I-84 Danbury Project Supplemental Needs and Deficiencies Study

Technical Memorandum No. 2

I-84 Danbury Project

State Project Number 34-349

December 2020

CONNECTICUT DEPARTMENT OF TRANSPORTATION

CDM Smith

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Section 1
Introduction

The study limits in the supplemental needs and deficiencies report is from the vicinity of the New York State Line easterly to the Kenosia Avenue bridge over I-84.

1.1 Study Background

The I-84 Interchange 3-8 Danbury study was initiated in 2016 and is currently ongoing. A Needs and Deficiencies Study was completed in October 2018. This study is currently in the Planning and Environmental Linkages (PEL) phase which will lead into the National Environmental Policy Act (NEPA) and the Connecticut Environmental Policy Act (CEPA) processes. The study is undertaking a substantial public involvement effort working with local and regional stakeholders and the community.

In late 2019, the Connecticut Department of Transportation (CTDOT) decided to extend the study limits of the I-84 Interchange 3-8 study to the west in the vicinity of the New York State Line for the following reasons:

- The New York State Department of Transportation (NYSDOT) is currently conducting a planning study along the I-684 and I-84 corridors. NYSDOT is considering improvements to the I-684/I-84 interchange in Brewster, New York easterly to the Connecticut state line.

- The Project Advisory Committee (PAC) and many stakeholders have requested the I-84 Danbury study extend further west to the New York state line. They noted that the west side of Danbury is experiencing increased development while Mill Plain Road (U.S. Route 1/202), which parallels I-84 between Interchanges 1 and 3, is severely congested.

1.2 Study Area

The limits of the study are I-84 in the vicinity of the New York State Line and Interchange 8 approximately 9.5 miles in length. In addition, the study extends on U.S. Route 7 between Interchanges 7 and 9 (west portion) and on U.S. Route 7 between I-84 and Interchange 11 (east portion) approximately 1.5 miles in length. **Figure 1-1** shows a study area map highlighting the study limits in "red".

I-84 is an interstate expressway oriented in an east-west direction between the New York State Line and Interchange 8. Within the study corridor, I-84 has two lanes in each direction between the New York State Line and Interchange 1 and then between Interchanges 7 and 8. Between Interchanges 1 and 7, I-84 has three lanes in each direction. I-84 meets U.S. Route 7 at two interchanges – on the west side at Interchange 3 and on the east side at Interchange 7.

U.S. Route 7 is classified as an expressway within the study corridor. *For the purposes of this report, U.S. Route 7 is referred as Route 7*. Within the corridor, Route 7 has primarily two lanes in each direction. The study area on Route 7 on the west side extends to Worcester Heights Rd./Miry Brook Road interchange (Interchange 7) to the I-84 merge and on the east side from the

I-84 split to about White Turkey Road Extension (Interchange 11). I-84 and Route 7 are combined between Interchanges 3 and 7.

Other key roadways within the study area include U.S. Route 6 (Mill Plain Road on the west), Route 37 (North Street), Route 39 (Main Street), Route 53 (Main Street), Route 805 (Federal Road), and Route 806 (Newtown Road).

Figure 1-1
Study Area

Section 2
Existing Transportation Conditions

The Needs and Deficiencies Report dated October 2018 includes the background information and data collection methodologies associated with the evaluation of the existing transportation conditions from the Kenosia Avenue bridge over I-84 easterly to Interchange 8 on I-84**. This section supplements the existing transportation conditions on I-84 from the vicinity of the New York State line easterly to the Kenosia Avenue bridge over I-84.**

2.1 Existing Traffic Data

Mainline Traffic Data

Mainline traffic data on I-84 was collected using MioVision equipment between Interchanges 2 and 3 on two separate days – Thursday, October 13 and Friday, October 14, 2016. Additional mainline traffic counts were obtained from CTDOT's historical volume repository for the most recent traffic data.

Ramp Traffic Counts

The ramp traffic count volumes for the Saw Mill Road interchange (Interchange 1) were obtained from the Summit Development Project.[1] The ramp traffic count volumes for the Milestone Road/Old Ridgebury Road interchange were collected as part of the data collection program conducted in 2016.

Intersection Peak Hour Traffic Volumes

The intersection peak hour traffic volumes for the Saw Mill Road interchange (Interchange 1) were obtained from the Summit Development Project. The intersection peak hour traffic count volumes for the Milestone Road/Old Ridgebury Road interchange were collected as part of the data collection program conducted in 2016.

Table 2-1 Existing (2016) Traffic Volumes – I-84

Location	Weekday Daily Traffic Volume (vehicles per day)		
	East	West	
New York Line and Interchange 1	37,000*	27,000*	64,000*
Interchange 1 and Interchange 2	35,000*	33,000*	68,000*
Interchange 2 and Interchange 3	38,800	42,400	81,200
	Weekday AM Peak Hour Volume (vehicles per hour)		
New York Line and Interchange 1	1,730	2,400	4,130
Interchange 1 and Interchange 2	1,730	2,950	4,680
Interchange 2 and Interchange 3	1,820	3,750	5,570
	Weekday PM Peak Hour Volume (vehicles per hour)		
New York Line and Interchange 1	3,240	2,530	5,770
Interchange 1 and Interchange 2	3,100	2,540	5,640

[1] Summit Development Traffic Impact Study conducted by Hardesty and Hanover, March 2020.

Location	Weekday Daily Traffic Volume (vehicles per day)		
	East	West	
Interchange 2 and Interchange 3	3,510	2,650	6,160

Note: * - Estimated based on peak hour traffic volumes.
Source: CDM Smith based on MioVision count data.

2.2 Existing Traffic Operations

This section shows the results of the traffic operations analysis for the mainline segments, ramps, and intersections for the section between the New York State line and Interchange 3.

2.2.1 Mainline Segment Operations

This section focusses on the mainline segment operations along I-84.

Methodology/Criteria

The VISSIM model was used to determine levels of service along I-84 segments during weekday A.M. and P.M. peak hour periods. **Table 2-2** highlights the level of service (LOS) criteria for freeway mainline segments. The level of service criteria for freeway segments is based on maximum density defined in terms of passenger cars per mile per lane (pc/mi/lane).

Table 2-2 LOS Criteria for Freeway Segments

Level of Service	Maximum Density (pc/mi/lane)
A	11
B	18
C	26
D	35
E	45
F	>45

Source: 2010 Highway Capacity Manual

I-84 Mainline Operations

Tables 2-3 and **2-4** show LOS analysis results for I-84 mainline segments in the eastbound and westbound directions respectively under existing (2016) conditions. The LOS tables are broken down by weekday A.M. and P.M. peak hour periods.

Table 2-3 Existing (2016) I-84 Segment Levels of Service – Eastbound Direction

Location			Weekday A.M. Peak			Weekday P.M. Peak		
Start	End	Length (ft)	Volume	Density (pc/mi/ln)	LOS	Volume	Density (pc/mi/ln)	LOS
Interchange 1 Off **To Saw Mill Road**	Interchange 1 On **From Saw Mill Road**	2,000	1540	12.9	B	2890	22.1	C
Interchange 1 On **From Saw Mill Road**	Interchange 2 Off **To Milestone Road**	2,770	1730	9.3	A	3100	15.4	B
Interchange 2 Off **To Milestone Road**	Interchange 2A On **From Milestone Road**	2,820	1270	10.8	A	2660	20.6	C
Interchange 2A On **From Milestone Road**	Interchange 2B On **From Old Ridgebury Road**	1,570	1340	7.6	A	2820	14.6	B
Interchange 2B On **From Old Ridgebury Road**	Interchange 3 Off **To Route 7 Southbound**	8,600	1820	10.1	A	3510	18.3	C

Table 2-4 Existing (2016) I-84 Segment Levels of Service – Westbound Direction

Location			Weekday A.M. Peak			Weekday P.M. Peak		
Start	End	Length (ft)	Volume	Density (pc/mi/ln)	LOS	Volume	Density (pc/mi/ln)	LOS
Interchange 1 Off **To Saw Mill Road**	Interchange 1 On **From Saw Mill Road**	3,190	2230	22.0	C	2340	22.0	C
Interchange 2 On **From Milestone Road**	Interchange 1 Off **To Saw Mill Road**	2,450	2950	21.0	C	2540	14.6	B
Interchange 2 Off **To Milestone Road**	Interchange 2 On **From Milestone Road**	2,970	2760	17.4	B	2200	13.2	B
Interchange 3 On **From Route 7 Northbound**	Interchange 2 Off **To Milestone Road**	9,790	3750	20.6	C	2650	14.5	B

Eastbound Direction

All mainline segments operate at LOS C or better.

Westbound Direction

All mainline segments operate at LOS C or better.

2.2.2 Mainline-Ramp Junction Operations

This section focusses on the mainline and ramp junction operations along I-84.

Methodology/Criteria

The VISSIM model was used to determine levels of service along I-84 during the weekday A.M. and P.M. peak hour periods. **Table 2-5** highlights the LOS criteria for freeway-ramp junctions. The level of service criteria for mainline-ramp junctions is based on maximum density defined in terms of passenger cars per mile per lane (pc/mi/lane).

Table 2-5 LOS Criteria for Freeway-Ramp Junctions

Level of Service	Maximum Density (pc/mi/lane)
A	10
B	20
C	28
D	35
E	>35
F	Demand exceeds capacity

I-84 Ramp Levels of Service

Tables 2-6 and **2-7** show LOS analysis results for I-84 merge and diverge ramp junctions in the eastbound and westbound directions respectively under existing (2016) conditions. The LOS tables are broken down by weekday A.M. and P.M. peak hour periods. No ramp junctions show LOS E or F under existing conditions.

Table 2-6 Existing (2016) I-84 Ramp Levels of Service – Eastbound Direction

Location	Weekday AM Peak				Weekday PM Peak			
	Volume				Volume			
	Mainline	Ramp	Density (pc/mi/ln)	LOS	Mainline	Ramp	Density (pc/mi/ln)	LOS
Interchange 1 – Saw Mill Road								
Off Ramp	1730	190	9.4	A	3240	350	16.4	B
On Ramp	1540	190	9.3	A	2890	210	15.2	B
Interchange 2 – Milestone Road								
Off Ramp	1730	460	9.3	A	3100	440	15.6	B
Milestone Road - On Ramp	1270	70	7.6	A	2660	160	14.6	B
Old Ridgebury Road - On Ramp	1340	480	7.1	A	2820	690	12.9	B

Table 2-7 Existing (2016) I-84 Ramp Levels of Service – Westbound Direction

Location	Weekday AM Peak				Weekday PM Peak			
	Volume				Volume			
	Mainline	Ramp	Density (pc/mi/ln)	LOS	Mainline	Ramp	Density (pc/mi/ln)	LOS
Interchange 1 – Saw Mill Road								
On Ramp	2230	170	15.2	B	2340	190	15.6	B
Off Ramp	2950	720	23.7	C	2540	200	15.8	B
Interchange 2 – Milestone Road								
On Ramp	2760	190	13.8	B	2200	340	11.6	B
Off Ramp	3750	990	16.3	B	2650	450	11.6	B

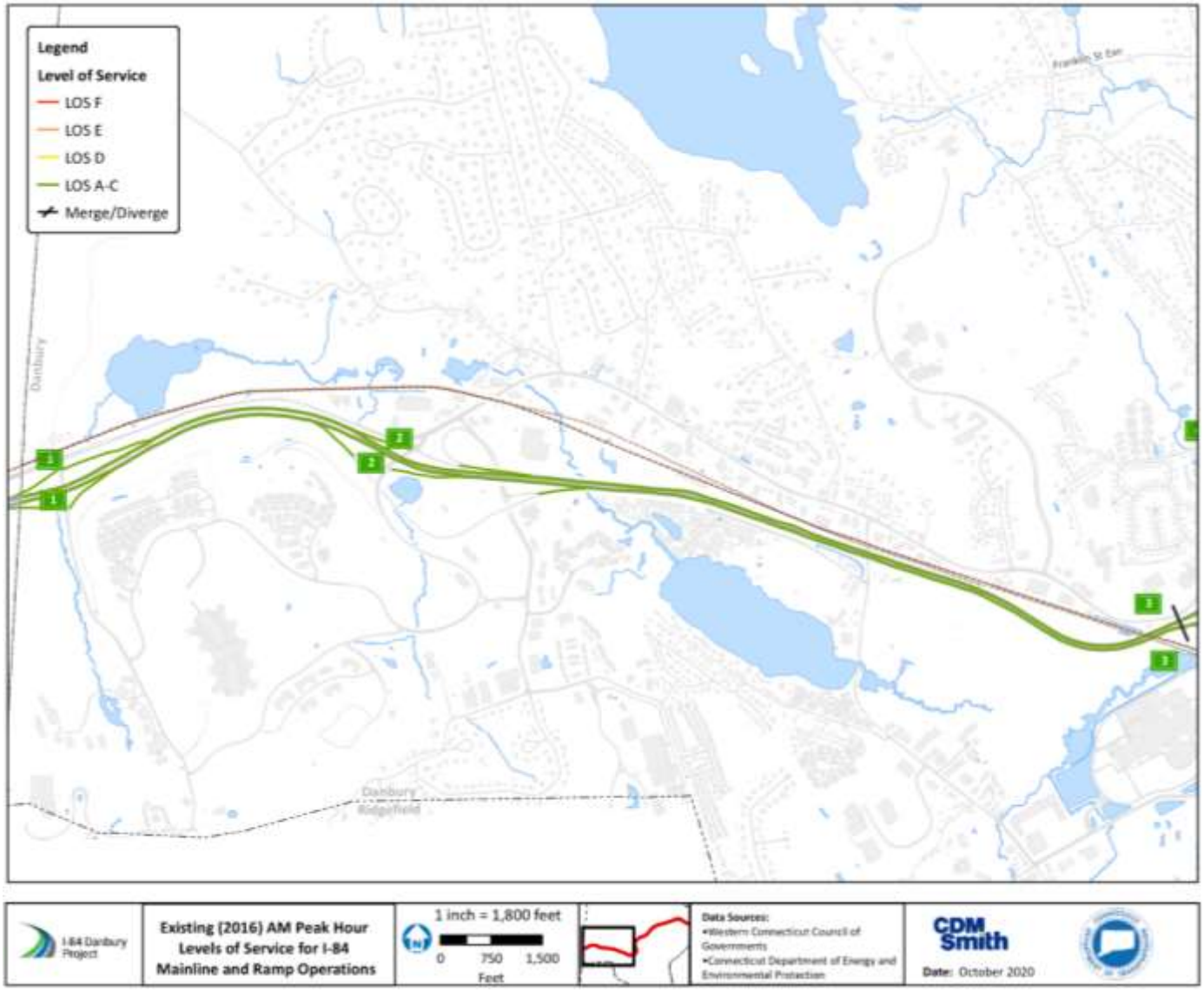

Figure 2-1
Existing (2016) Weekday A.M. Peak Hour Levels of Service for I-84

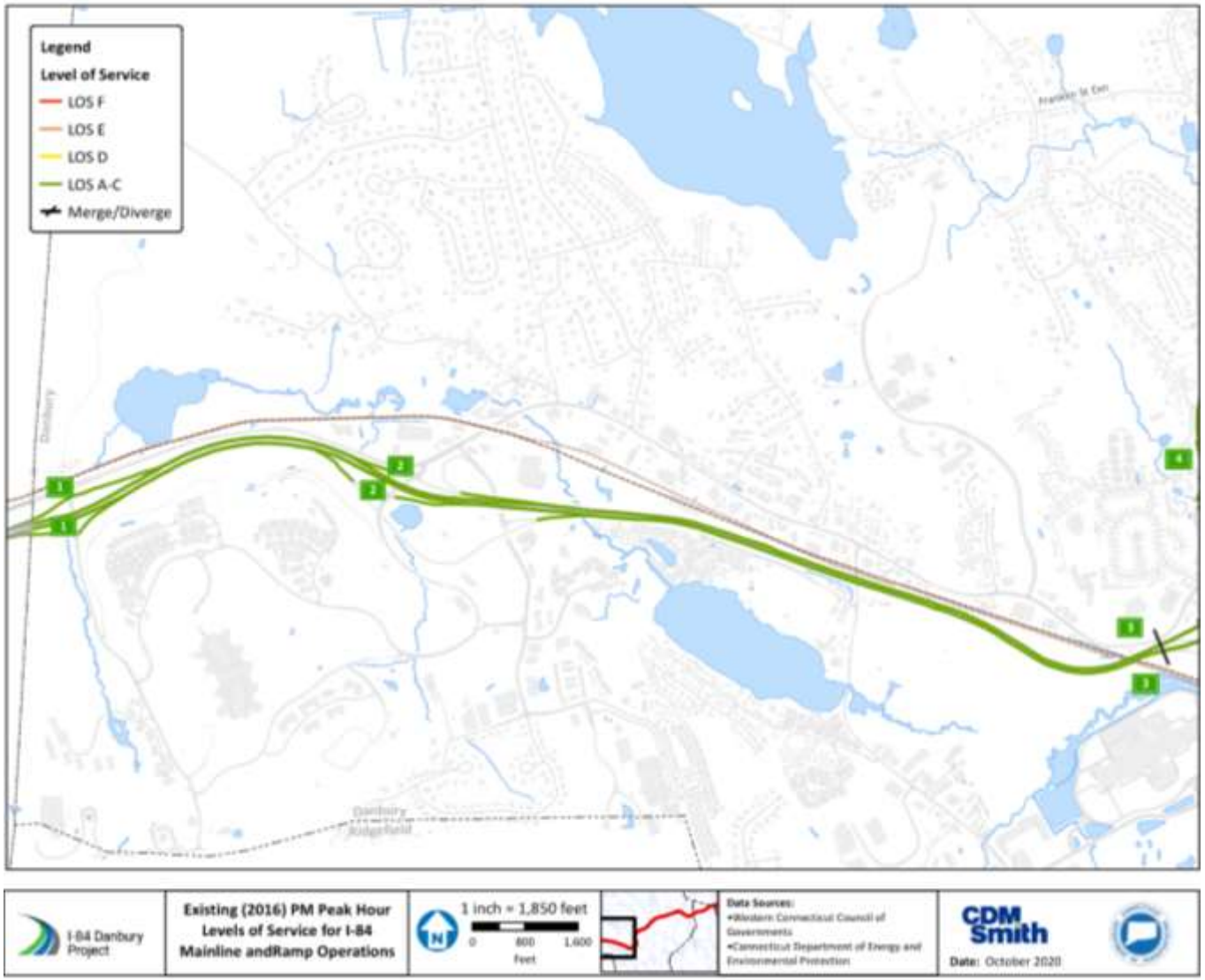

Figure 2-2
Existing (2016) Weekday P.M. Peak Hour Levels of Service for I-84

2.2.3 Intersection Operations

This section focusses on the levels of service (LOS) of intersections located within the study area.

Methodology/Criteria

A SYNCHRO model was built for the study area intersections identified earlier. This model provides the ability to evaluate intersection operations along the I-84 corridor. LOS was determined for signalized and un-signalized intersections during the weekday A.M. and P.M. peak hour periods.

Table 2-8 highlights the level of service criteria for signalized intersections. The level of service criteria for signalized intersections is based on control delay per vehicle measured in seconds.

Table 2-8 LOS Criteria for Signalized Intersections

Level of Service	Control Delay per Vehicle (seconds)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	> 80

There are no unsignalized (stop-controlled) intersections within the extended study limits.

Levels of Service

Tables 2-9 shows LOS analysis results for signalized intersections along the I-84 interchanges 1 and 2 under existing (2016) conditions. The LOS tables are broken down by weekday A.M. and P.M. peak hour periods. The existing signal phasing and operation was confirmed in the field and timings were obtained from the City or CTDOT for use in the SYNCHRO analysis.

All intersections as listed below operate at an overall LOS C or better. All movements have a (v/c) ratio of less than 1.0 and a LOS of D or better under existing conditions.

Table 2-9 Existing (2016) Signalized Intersection Levels of Service – I-84 Interchanges

Location			Weekday A.M. Peak			Weekday P.M. Peak		
			V/C	Delay	LOS	V/C	Delay	LOS
Interchange 1								
Danbury Road/ Mill Plain Road (US 6/202) at Saw Mill Road			--	**25.1**	**C**	--	**19.4**	**B**
Danbury Road (Route 6/202)	EB	TR	0.41	20.5	C	0.57	22.6	C
Mill Plain Road (Route 6/202)	WB	L		46.2	D	0.44	33.7	C
		T	0.63	32.0	C	0.21	8.8	A
Saw Mill Road	NB	LR	0.55	21.0	C	0.25	14.0	B
Saw Mill Road at I-84 WB Off-Ramp			--	**24.8**	**C**	--	**7.7**	**A**
I-84 WB Off Ramp	WB	L	0.42	43.6	D	0.41	38.3	D
		LTR	0.83	36.2	D	0.49	13.3	B
Saw Mill Road	NB	L	0.14	7.1	A	0.23	4.3	A
		T	0.15	6.3	A	0.11	2.8	A
Saw Mill Road	SB	TR	0.16	4.8	A	0.19	1.8	A
Saw Mill Road at I-84 EB Off-Ramp			--	**8.0**	**A**	--	**12.3**	**B**
I-84 EB Off Ramp	EB	LTR	0.47	9.4	A	0.70	17.4	B
Saw Mill Road	NB	T	0.42	13.0	B	0.35	15.8	B
		R	0.19	3.4	A	0.14	4.9	A
Saw Mill Road	SB	LT	0.18	4.1	A	0.26	6.4	A

Table 2-9 Existing (2016) Signalized Intersection Levels of Service – I-84 Interchanges (continued)

Location			Weekday A.M. Peak				Weekday P.M. Peak		
			V/C	Delay	LOS		V/C	Delay	LOS
Interchange 2									
Mill Plain Road (US 6/202) at Milestone Road			--		**B**	--	**16.1**		**B**
Mill Plain Road (Route 6/202)	EB	L	0.09	16.1	B	0.19	21.8		C
		TR	0.10	12.7	B	0.29	19.3		B
Mill Plain Road (Route 6/202)	WB	L	0.23	7.3	A	0.36	10.7		B
		T	0.25	7.1	A	0.23	9.4		A
		R	0.07	0.1	A	0.21	4.9		A
Milestone Road	NB	L	0.14	39.0	D	0.16	33.9		C
		T	0.33	41.2	D	0.53	40.7		D
		R	0.60	5.2	A	0.69	11.9		B
Milestone Road	SB	L	0.20	24.3	C	0.42	25.1		C
		TR	0.15	15.8	B	0.30	13.8		B
Milestone Road at I-84 WB Off-Ramp			--	**3.9**	**A**	--	**2.7**		**A**
I-84 WB Off Ramp	WB	L	0.34	37.3	D	0.25	35.9		D
		TR	0.39	1.7	A	0.45	2.5		A
Milestone Road	NB	LT	0.13	1.2	A	0.22	1.1		A
Milestone Road	SB	TR	0.11	0.8	A	0.18	1.2		A
Milestone Road at I-84 EB Off-Ramp			--	**23.6**	**C**	--	**23.1**		**C**
I-84 EB Off Ramp	EB	LTR	0.74	36.7	D	0.79	34.5		C
Milestone Road	NB	TR	0.04	4.3	A	0.09	7.4		A
Milestone Road	SB	LT	0.08	7.2	A	0.14	10.4		B

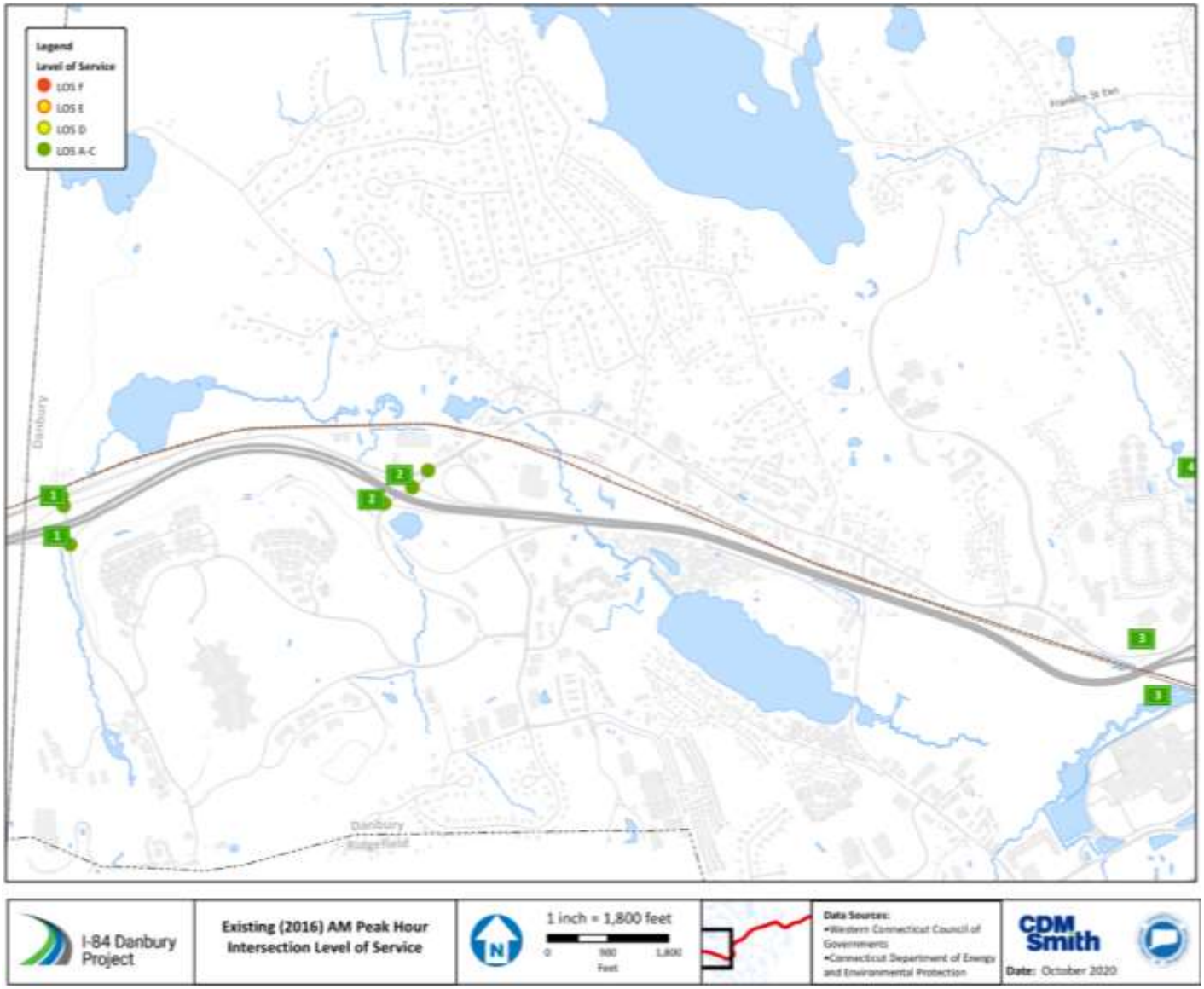

Figure 2-3
Existing (2016) Weekday A.M. Peak Hour Intersection Levels of Service

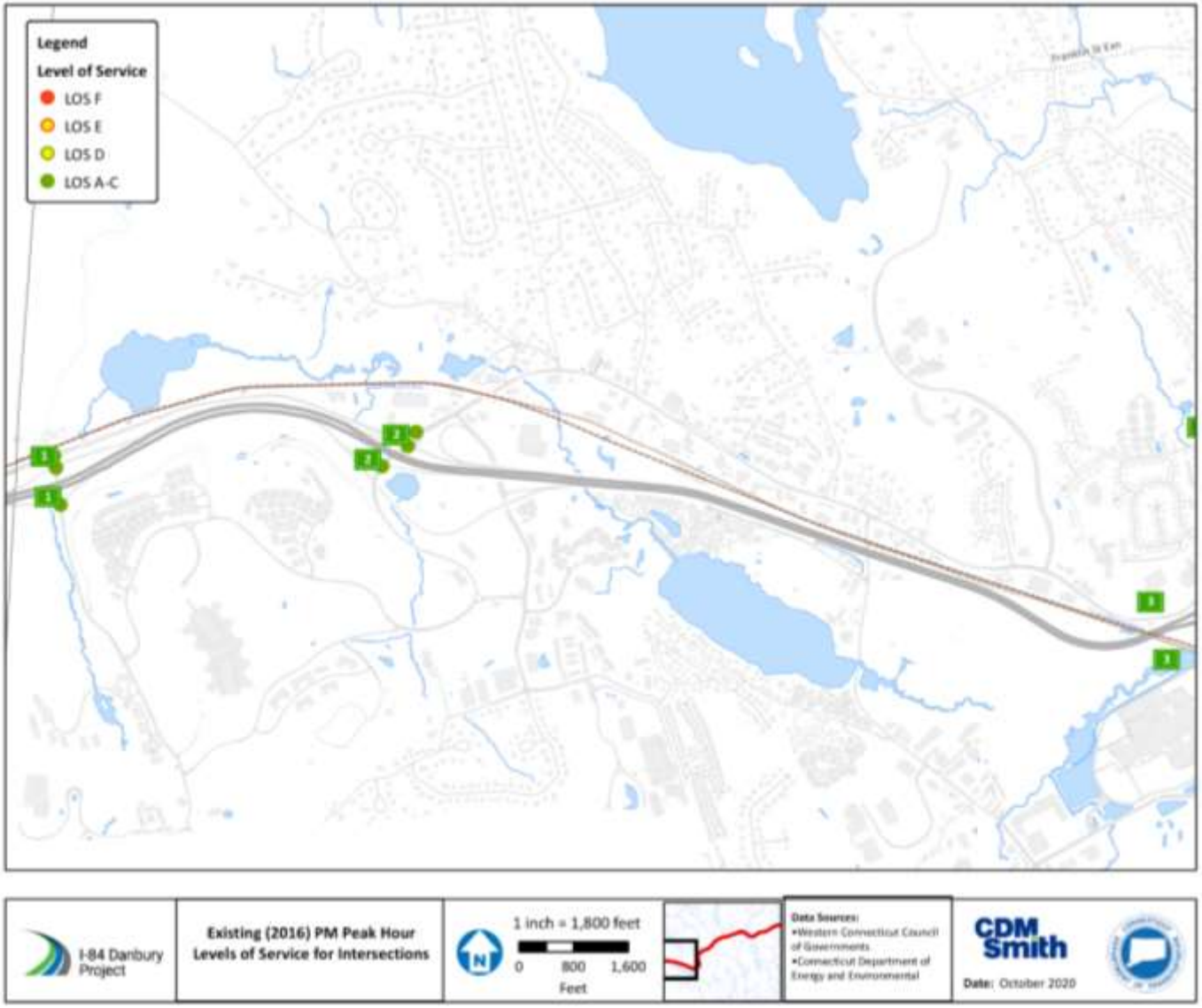

Figure 2-4
Existing (2016) Weekday P.M. Peak Hour Intersection Levels of Service

2.3 Geometrics

2.3.1 Existing Highway Geometry Analysis Methodology

The methodology used to define deficiencies in the existing highway geometrics on I-84 and Ramp in this section followed the same methodology as in the original Needs and Deficiencies Report.

2.3.2 Presentation of Highway & Ramp Deficiencies

The additional two segments of I-84 corridor were evaluated for deficiencies are as follows:

The segments run west to east along I-84 Eastbound are:

- Segment 1: Interchange 1 Off-Ramp to Interchange 2 Off-Ramp
- Segment 2: Interchange 2 Off-Ramp to Kenosia Avenue Overpass

The segments run west to east along I-84 Westbound are:

- Segment 1: Interchange 1 On-Ramp to Interchange 2 On-Ramp
- Segment 2: Interchange 2 On-Ramp to Kenosia Avenue Overpass

Each of the fifteen (15) controlling design criteria was analyzed for each segment along the I-84 corridor from Interchange 1 to Kenosia Avenue Overpass, with the exception of the auxiliary lane widths and superelevation rate/transition length criteria. A criteria matrix was created to summarize the two segments of I-84 that contain deficiencies within the existing highway geometry. The deficiencies in each segment along the Eastbound and Westbound I-84 travel lanes are summarized in **Figure 2-5** at the end of this section. Within this figure, the controlling geometric design criteria are listed across the top of the criteria matrix, with the individual segments of the corridor listed along the left column. A red dot denotes that either a portion or the entire length of a segment does not meet the minimum controlling design criteria, a yellow dot denotes that either a portion or the entire length of a segment marginally meets the minimum controlling design criteria, and a green dot denotes that the entire length of a segment meets the minimum controlling design criteria.

Along with the criteria matrix, detailed calculations noting geometric measurements in comparison to minimum design criteria are provided.

2.3.3 I-84 Mainline Geometry Review

Each of the two segments along both Eastbound and Westbound I-84 were analyzed based on the controlling design criteria from the CTDOT Highway Design Manual (HDM), 2003. This section summarizes the results of the analysis and highlights all geometric deficiencies along the I-84 corridor. Refer to **Figure 2-1** for the criteria matrix for I-84 Eastbound and Westbound.

Design Speed:

The design speed along both Eastbound and Westbound I-84 within these two segments meet the minimum required design speed.

Travel Lane and Shoulder Widths:

The travel lane widths along both Eastbound and Westbound I-84 within these two segments meet the minimum required travel lane width.

The left and right shoulder widths vary in this section. **Table 2-10** summarizes the segments of I-84 Eastbound which do not meet the required left shoulder widths.

Table 2-10 I-84 Eastbound Left Shoulder Width Deficiencies

Segment No.	Segment	Required Left Shoulder Width (ft)	Actual Left Shoulder Width (ft)
1	Interchange 1 Off-Ramp to Interchange 2 Off-Ramp	8	4

Bridge Widths:

Table 2-11 summarizes the bridges within these two segments of I-84 Eastbound and Westbound which do not meet the required left shoulder width.

Table 2-11 I-84 Eastbound & Westbound Bridges with Left Shoulder Width Deficiencies

Segment No.	Structure No.	Carries	Crossing	Required Left Shoulder Width (ft)	Actual Left Shoulder Width (ft)
1	05760	I-84 EB	Saw Mill Road	8	4
1	05760	I-84 WB	Saw Mill Road	8	6

Minimum Radius and Compound Curves Not Meeting 1.5:1 Ratio:

The horizontal curves on the Eastbound and Westbound within these two segments meet the minimum radius based on design speed.

There is no horizontal compound curve on the Eastbound or Westbound alignments within these two segments.

Stopping Sight Distance on Vertical Curves and Maximum Grades:

Table 2-12 summarizes the segments of I-84 Eastbound in which the vertical curves do not meet minimum stopping sight distance requirements.

Table 2-12 I-84 Eastbound Vertical Curve Stopping Sight Distance Deficiencies

Segment No.	Vertical Curve No.	Crest/Sag Vertical Curve	Measured Stopping Sight Distance (ft)	AASHTO Greenbook Required Stopping Sight Distance (ft)
2	3	Crest	561	645

The vertical grades of both segments on the Eastbound and Westbound meet the maximum allowable vertical grade of 4%.

Travel Lane and Shoulder Cross Slopes:

From visual inspection of Eastbound and Westbound I-84 within these two segments, the travel lane and shoulder cross slopes are assumed to meet the minimum requirements for travel lane and shoulder cross slopes.

Roadside Clear Zones:

From visual inspection of Eastbound and Westbound I-84 within these two segments there are no slope off the edge of shoulder is steeper than 4:1 that is not protected by guide rail. Therefore, both segments within the I-84 study limits meet the minimum requirements for roadside clear zones.

Intersection Sight Distance:

There are no intersections within these two segments where the intersection sight distance is deficient.

2.3.4 I-84 Ramp Geometry Review

There are ten ramps along both eastbound and westbound I-84 within these two segments analyzed based on the critical design elements and other design criteria outlined in the CTDOT HDM. This section summarizes the results of the analysis and highlight all geometric deficiencies of the ramps along the I-84 corridor. Refer to **Figure 2-6** for the criteria matrix for I-84 Eastbound and Westbound ramps.

Minimum Length of Deceleration for an Exit Ramp:

The length of deceleration for exit ramps on I-84 Eastbound and Westbound within these two segments meet the minimum required deceleration length.

Deflection (Taper) Angle for a Taper Exit Ramp:

The exit ramps on I-84 Eastbound and Westbound within these two segments are parallel ramps, therefore deflection taper angle does not apply.

Minimum Length of Acceleration for an Entrance Ramp:

The length of acceleration for entrance ramps on I-84 eastbound and westbound within these two segments are sufficient.

Parallel Portion of the Acceleration Lane for an Entrance Ramp:

All ramps meet the minimal 300 feet of parallel acceleration length and less than 1200 foot maximum.

Entrance and Exit Ramp Side of Road:

All ramps are on the driver side (right side) and therefore criteria is met for all ramps.

Interchange Spacing:

Interchange spacing was measured for the eastbound and westbound directions of I-84 separately, measuring the distance along the mainline between the centroids of the entrance and exit ramp gore areas for each pair of ramps. All ramps within the two segments meet the recommended interchange spacing of greater than a mile.

Terminal spacing is measured as the distance between gore areas of successive terminals. All exit and entrance terminal spacings meet the recommended minimum distance of 1500 ft for exit spacing, and 800 ft for entrance spacing.

Ramp Design Speed:

Ramps were classified as ramps for right turns, loop ramps, semidirect connections, and direct connections to determine the appropriate range of design speeds. **Table 2-13 and 2-14** indicate the ramps in these 2 segments which requires changes in speed between the ramp and mainline.

Table 2-13 I-84 Eastbound Ramp Design Speed Deficiencies

Interchange No.	Exit or Entrance	Ramp Type	Design Speed (mph)	Required Design Speed Range (mph)
1	Entrance	Semidirect Connection	42	50-60

Table 2-14 I-84 Westbound Ramp Design Speed Deficiencies

Interchange No.	Exit or Entrance	Ramp Type	Design Speed (mph)	Required Design Speed Range (mph)
2A	Exit	Ramp for Right Turn	28	30-45
2B	Exit	Ramp for Right Turn	28	50-60

2.3.5 Existing Highway Geometric Deficiency Conclusions

This report illustrates the following highway characteristics which contribute to the deficiencies of the corridor:

- Substandard ramp design speed
- Substandard shoulder widths

I-84 EASTBOUND HIGHWAY GEOMETRICS

Segment No.	Segment	Design Speed	Travel Lane Widths	Shoulder Widths	Structures	Horizontal Alignment		Vertical Curvature			Stopping Sight Distance (Based on Level Grades)	Travel Lane & Shoulder Cross Slopes	Roadside Clear Zones	Intersection Sight Distance
					Bridge Widths & Cross Slopes	Minimum Radius	Compound Curves Not Meeting 1.5:1 Ratio	Stopping Sight Distance at Crest Vertical	Stopping Sight Distance at Sag Vertical Curves	Maximum Grades				
1	Exit 1 Off-Ramp to Exit 2 Off-Ramp	●	●	●	●	●	N/A	●	●	●	●	●	●	N/A
2	Exit 2 Off-Ramp to Kenosia Avenue Overpass	●	●	●	●	●	N/A	●	●	●	●	●	●	N/A

I-84 WESTBOUND HIGHWAY GEOMETRICS

Segment No.	Segment	Design Speed	Travel Lane Widths	Shoulder Widths	Structures	Horizontal Alignment		Vertical Curvature			Stopping Sight Distance (Based on Level Grades)	Travel Lane & Shoulder Cross Slopes	Roadside Clear Zones	Intersection Sight Distance
					Bridge Widths & Cross Slopes	Minimum Radius	Compound Curves Not Meeting 1.5:1 Ratio	Stopping Sight Distance at Crest Vertical	Stopping Sight Distance at Sag Vertical Curves	Maximum Grades				
1	Exit 1 On-Ramp to Exit 2 On-Ramp	●	●	●	●	●	N/A	●	●	●	●	●	●	N/A
2	Exit 2 On-Ramp to Kenosia Avenue Overpass	●	●	●	●	●	N/A	●	●	●	●	●	●	N/A

● = Meets Controlling Design Criteria

● = Marginally Meets Controlling Design Criteria

● = Does Not Meet Controlling Design Criteria

Figure 2-5
I-84 Eastbound and Westbound Geometric Criteria Matrix

I-84 EASTBOUND RAMPS

Exit	Direction	On/ Off	Ramp Type	Critical Design Elements				Other Design Criteria					
				Length of Deceleration	Deflection (Taper) Angle for Taper Exit Ramp (2 to 5 degrees)	Length of Acceleration	Parallel Portion of Acceleration Lane (>300 ft)	Side	Terminal Spacing		Interchange Spacing (>1 mile)		Ramp Design Speed
									Backward	Forward	Backward	Forward	
1	EB	Off	Diamond	●	N/A	N/A	N/A	●	●	●	●	●	●
1	EB	On	Diamond	N/A	N/A	●	●	●	●	●			●
2	EB	Off	Diamond	●	N/A	N/A	N/A	●	●	●			●
2	EB	On	Diamond	N/A	N/A	●	●	●	●	●	●	●	●
2A	EB	On	Diamond	N/A	N/A	●	N/A	●	●	●			●

I-84 WESTBOUND RAMPS

Exit	Direction	On/ Off	Ramp Type	Critical Design Elements				Other Design Criteria					
				Length of Deceleration	Deflection (Taper) Angle for Taper Exit Ramp (2 to 5 degrees)	Length of Acceleration	Parallel Portion of Acceleration Lane (>300 ft)	Side	Terminal Spacing		Interchange Spacing (>1 mile)		Ramp Design Speed
									Backward	Forward	Backward	Forward	
1	WB	On	Diamond	N/A	N/A	●	●	●	●	●	●	●	●
1	WB	Off	Diamond	●	N/A	N/A	N/A	●	●	●			●
2	WB	On	Diamond	N/A	N/A	●	●	●	●	●			●
2A	WB	Off	Free-Flow Loop	●	N/A	N/A	N/A	●	●	●	●	●	●
2B	WB	Off	Diamond	●	N/A	N/A	N/A	●	●	●			●

● = Meets Controlling Design Criteria

● = Does Not Meet Controlling Design Criteria

Figure 2-6
I-84 Eastbound and Westbound Ramp Geometric Criteria Matrix

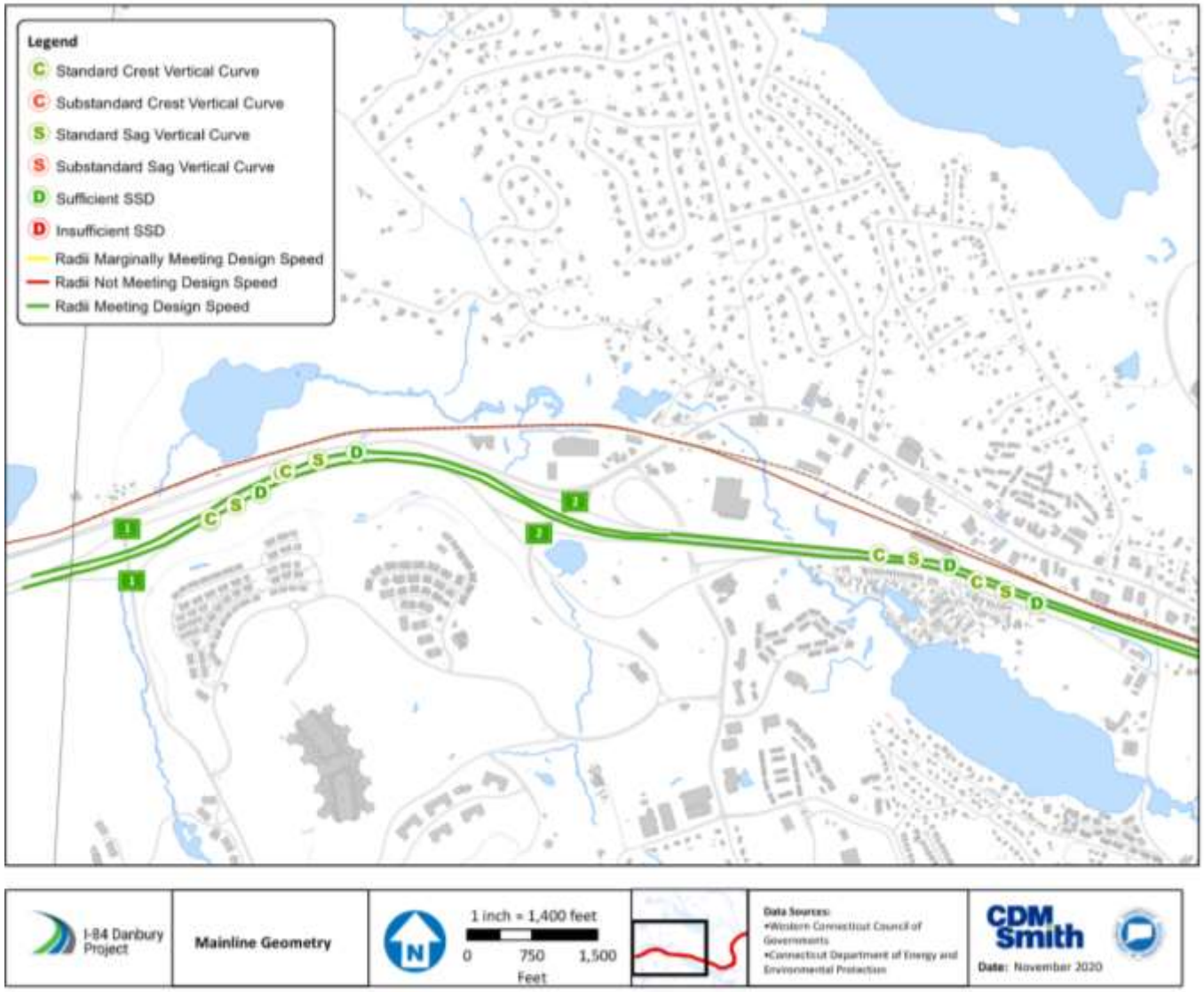

Figure 2-7
I-84 Mainline Geometry

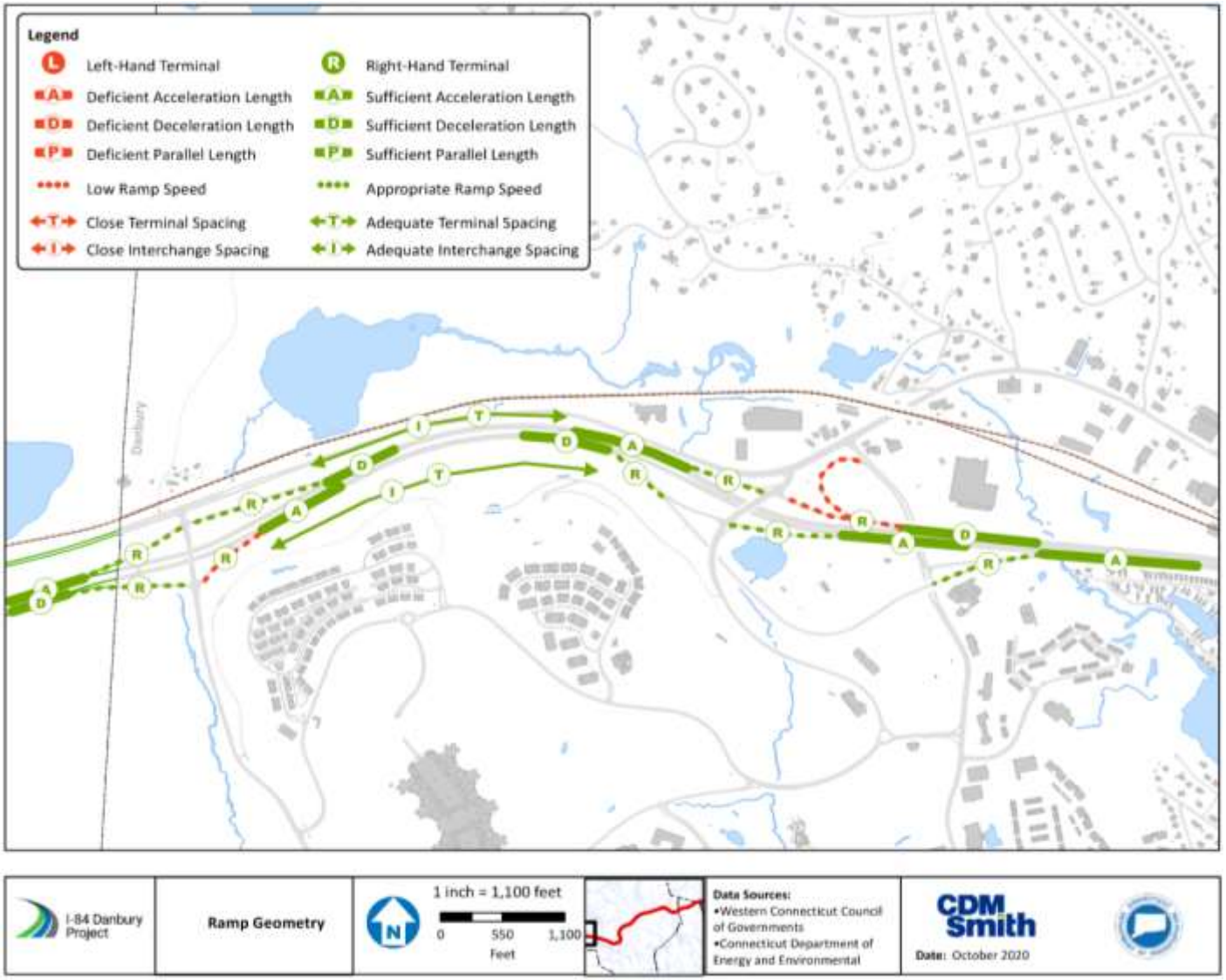

Figure 2-8
I-84 Ramp Geometry

2.4 Structural Conditions Review

2.4.1 Structural Overview

There are total of six (6) remaining structures between the New York State Line and Interchange 2. These consist of five bridges and one culvert. Inspection reports from August 2018 to February 2020 were utilized as the basis for current conditions.

The structures are classified by the following functional groups:

- Bridges carrying I-84 (I-84)
- Bridges carrying local roads over I-84 (Over I-84)
- Culverts carrying I-84 or State Routes (Culvert)

The I-84 interstate within the study limits and the structures carrying roads over it were built in the late 1950's, which accounts for two of the bridges. Two of the bridges were originally constructed in the late 1950's, but were fully replaced in the early 1980's. The remaining two bridges were built in the early 1980's.

Overall, all of the bridges are in satisfactory condition or better, and none of the bridges have substandard load ratings. Four of the bridges within the extended limits have substandard bridge railing. There is only one structure with fatigue prone details and is well maintained and had no notable deficiencies.

Table 2-15 below lists the major deficiencies found within the extended study limits, and the percentage of the bridges by count and deck area that had those deficiencies. The percentages are based on the six (6) structures within the study limits. The evaluation of this criteria will assist in understanding the replacement versus rehabilitation needs within the corridor, which will be used to evaluate life cycle cost and alternatives analysis.

Table 2-15 Overview of Bridge Deficiencies

Deficiency		% by Count	% by Deck Area
CONDITION			
	Structures without Rehabilitation	33%	33%
	Fair Condition	0%	0%
	Substandard Load Rating	0%	0%
SAFETY			
	Substandard Bridge Width	100%	100%
	Substandard Vertical Clearance	17%	14%
	Horizontal Underclearance Requiring Corrective Action	17%	14%
	Substandard Underpass Width	33%	39%
	Substandard Bridge Railing	67%	53%
STRUCTURE			
	Fracture Critical/Fatigue Prone Details	17%	10%
	Structure within FEMA	0%	0%
	Skew Angle >30%	50%	39%

Historical inspections and rehabilitation projects were evaluated to understand the current condition and maintenance needs of the existing structures. This information was used to estimate the future component condition ratings and assess maintenance, rehabilitation or

replacement required by the year 2037. **Section 3** will further outline the results of the future condition analysis.

Figure 2-9 at the end of this section displays the bridge and culvert locations throughout the study extended limits. The following sections provide existing bridge conditions considering the selected deficiency criteria.

2.4.2 Condition

History of Rehabilitation

Within the extended limits, three of the bridges, one of which is a culvert, have had full replacements. Two of the bridges have not been rehabilitated since their original construction. Three of the bridges had joint replacements in 2011. See **Table 2-16** below for summary of the typical bridge rehabilitations within the corridor.

Table 2-16 Rehabilitation Summary

Type of Work	No. Bridges	%
Deck Replacement	1	17%
Deck Rehabilitation	0	0%
Widening	2	33%
Full Replacement	3	50%
Joint Replacement	3	50%
Bearing Replacement	1	17%
Painting	0	0%
Substructure Repair	0	0%

There are four bridge structures that carry I-84 within the extended limits. The average minimum condition rating between the major components of each structure is approximately 6. Based on this information, it can be determined that the overall maintenance and up-keep of the bridges carrying I-84 within these extended limits has been satisfactory. Two of these structures had a full replacement and one structure was widened with improvements made to the intermediate girders and bearings. There is one bridge structure carrying I-84 which was originally built in 1980 that did not have any replacements or rehabilitations. **Table 2-17** below displays the rehabilitation projects associated with the bridges carrying I-84.

Table 2-17 Rehabilitation of Bridges Carrying I-84

Plan Year	Proj. No.	Project Description	Bridges
1980	0034-0162	Full bridge replacement	05306, 05307
1987	0034-0214	Replace intermediate girders, add median stringers to combine EB and WB structures, replace deck, construct abutments in median area, bearing replacement, bearing keeper devices	05760
2011	0174-0357	Asphaltic plug expansion joint system without bridging plates, silicone joint sealant treatment at parapets and medians	05306, 05307, 05760

There is one structure carrying a local road over I-84 which was built in 1980. This structure did not have any rehabilitations or replacements. There are no structures within the extended limits that carry Route 7, therefore no rehabilitation information has been provided.

The one culvert within the limits has been replaced and rehabilitated. Bridge No. 02531, which carries I-84 over Sawmill River, was relocated in 1958 under Project 0034-0093 and then extended in 1980 under Project 0034-0162.

Bridge Condition

Overall, the condition of the bridges is satisfactory or good. The deck and substructure of all structures within the extended limits are in good condition. None of the bridges or culverts within the extended limits have sufficiency ratings less than 50%.

The majority of the bridges within the extended limits have superstructures in good condition with only one structure as satisfactory. The bridge in satisfactory condition, Bridge No. 05760, exhibits areas of peeling paint and moderate rust on webs and bottom flanges of the girders. In addition, the fascia girders have evidence of collision damage. **Table 2-18** outlines the overall condition for deck, superstructure and substructure for the five bridges within the extended limits.

Table 2-18 Bridge Condition Summary

Rating		Deck		Superstructure		Substructure	
		No.	%	No.	%	No.	%
5	Fair	0	0%	0	0%	0	0%
6	Satisfactory	0	0%	1	20%	0	0%
7	Good	5	100%	4	80%	5	100%
8	Very Good	0	0%	0	0%	0	0%
Totals		5	100%	5	100%	5	100%

Table 2-19 contains the breakdown of the structural condition of the culvert within the extended limits. The culvert is considered satisfactory. It has locations of active leakage and efflorescence staining between adjacent units. There is isolated spalling with exposed rebar and hairline cracking.

Table 2-19 Culvert Condition Summary

Culvert Condition			
Rating		No.	%
5	Fair	0	0%
6	Satisfactory	1	100%
7	Good	0	0%
Totals		1	100%

Load Rating

Most of the bridges were load rated using BAR7 with HS-20 vehicular loading between the years 1994 and 2002. According to the inspection reports and available load rating reports, all bridges within the extended limits had a load rating greater than 1.

2.4.3 Safety

Bridge Width

Five of the six (83%) bridges within the extended corridor have adequate lane widths. However, most of the left and right shoulders are substandard. All bridges within the extended limits have at least one substandard element. **Table 2-20** displays the number of bridges that have standard versus substandard lanes and shoulders.

Table 2-20 Standard and Substandard Lane and Shoulder Widths (Bridge)

Element	Standard		Substandard		Total	
	No.	%	No.	%	No.	%
Lane	5	83%	1	17%	6	100%
Left Shoulder	0	0%	6	100%	6	100%
Right Shoulder	3	50%	3	50%	6	100%

Underclearance Geometry

One of the six bridges (17%) has substandard minimum vertical clearance for the full replacement condition and rehabilitation condition per HDM standards. This bridge is posted as shown in **Table 2-21**.

Table 2-21 Bridges Posted for Vertical Clearance

Bridge No.	Crossing Functional Class	Required Clearance per HDM	Posted Clearance
05760	Minor Arterial	14’-3”	13’-11”

Bridge No. 05760 has a lateral underclearance driving the NBI No. 69 rating to be three, requiring corrective action. The right side has a clearance less than two feet. This bridge, which carries I-84 over Saw Mill Road has abutments directly adjacent to both sides of the road. If this underpass needs to be widened because of the study, substructure elements may need to be relocated, which would be a major structural adjustment.

Underpass Roadway Width

Five of the bridges were evaluated for the underpass roadway width criteria. The remaining structure is a culvert. Overall, the lane widths were adequate. Of the bridges that are crossing roadways, two of the five (40%) have at least one substandard element. **Table 2-22** below displays the number of crossing roadways that have standard versus substandard lanes and shoulders. Left shoulders were not considered for bridges crossing roadways with two directions of travel.

Table 2-22 Standard and Substandard Lane and Shoulder Widths (Crossing Roadway)

Element	Standard		Substandard		Total	
	No.	%	No.	%	No.	%
Lane	5	100%	0	0%	5	100%
Left Shoulder	0	0%	1	100%	1	100%
Right Shoulder	3	60%	2	40%	5	100%

2.4.4 Traffic Safety Features

Two of the six (33%) bridges and culverts within the extended limits have all four traffic safety features that are substandard. As part of this study, the replacement of all substandard guardrail systems will be evaluated.

Bridge Railings: Approximately 67% of the bridges within the extended limits have substandard bridge railings, all of which are carrying I-84.

Transitions: 83% of the bridges within the extended corridor have substandard transitions, which accounts for all of the bridges except for the culvert.

Approach Guiderail: 83% of the bridges within the extended corridor have substandard approach guardrail, which accounts for all of the bridges except for the culvert.

Approach Guiderail Ends: Overall, 33% of the bridges within the corridor have substandard approach guardrail ends.

2.4.5 Structure

Seismic Retrofit

None of the bridge structures with the extended limits have undergone a seismic retrofit rehabilitation. Additionally, per AASHTO 4.7.4.4, none of the bridges in the extended limits have inadequate seat widths.

Fractural Critical and Fatigue Prone

None of the structures have fracture critical members. Only one structure, Bridge No. 05309, has a fatigue prone detail which is the misalignment of bolt holes with plug welds at the intermediate diaphragm connections. The inspection report noted that the Bridge No. 05309 fatigue prone details are well maintained and had no notable deficiencies **Table 2-23** displays the number of bridges with fracture critical and fatigue details based on their function.

Table 2-23 Fracture Critical and Fatigue Details

Bridge Function	No. Bridges	Fracture Critical		Fatigue Prone	
		No.	%	No.	%
I-84	4	0	0%	1	25%
Over I-84	1	0	0%	0	0%
Culvert	1	0	0%	0	0%
Total	6	0	0%	1	17%

Flooding, Waterway and Scour

There is one culvert within the extended limits which passes over a waterway; however, it is not located within a FEMA flood zone.

The waterway adequacy of the culvert has a rating of 8, which indicates for that roadway classification, that there is a slight (frequency of every 11 to 100 years per the FHWA Inspection Coding Guide) chance of overtopping bridge deck and roadway approaches.

None of the structures are deemed to be scour critical. The only waterway structure received a rating of 8, which indicates that the foundations are determined to be stable for assessed or calculated scour conditions and that calculated scour is above top of the footing. The culvert exhibited a channel and channel protection rating of 7, which indicates that the bank protection needs minor repairs and the river control devices and embankment protection have a little minor damage.

Structure Geometry

Three out of the five (60%) bridge structures within the study limits have skew angles greater than 30 degrees. See **Table 2-24** below for a breakdown of the structures with high skew angles by bridge function.

Table 2-24 Bridges with Skew Angles > 30 Degrees

Bridge Function		Skew > 30 deg.	
	No. Bridges	No.	%
I-84	4	3	75%
Over I-84	1	0	0%
Total	5	3	60%

Table **2-25** provides a summary of the structural conditions for the six (6) bridge structures.

Table 2-25 Summary of Structural Conditions

Bridge No.	Carries	Crossing	Bridge Condition	Bridge Capacity	Minimum Vertical Clearance	Underpass Lane/ Shoulder Adequacy	Adequate Seat Width	Fracture Critical/ Fatigue Prone Details	Scour Critical	Bridge Railing	Skew
02531	I-84	Sawmill River	6	1.39	N/A	N/A	Y	N	8	N/A	0.00
05306	I-84 WB	SR 824 (Woodland Road)	7	1.84	15.58	Y	Y	N	N	N	33.00
05307	I-84 EB	SR 824 (Woodland Road)	7	1.46	15.00	Y	Y	N	N	N	33.00
05308	Old Ridgebury Road	I-84 Ramp 242	7	1.92	16.67	N	Y	N	N	Y	6.00
05309	I-84 Ramp 243	SR 824 (Woodland Road)	7	1.92	15.58	Y	Y	Y	N	N	39.00
05760	I-84	Sawmill Road	7	1.67	13.92	N	Y	N	N	N	10.00

LEGEND
MEETS STANDARD
MODERATELY MEETS STANDARDS
SUBSTANDARD
NOT APPLICABLE

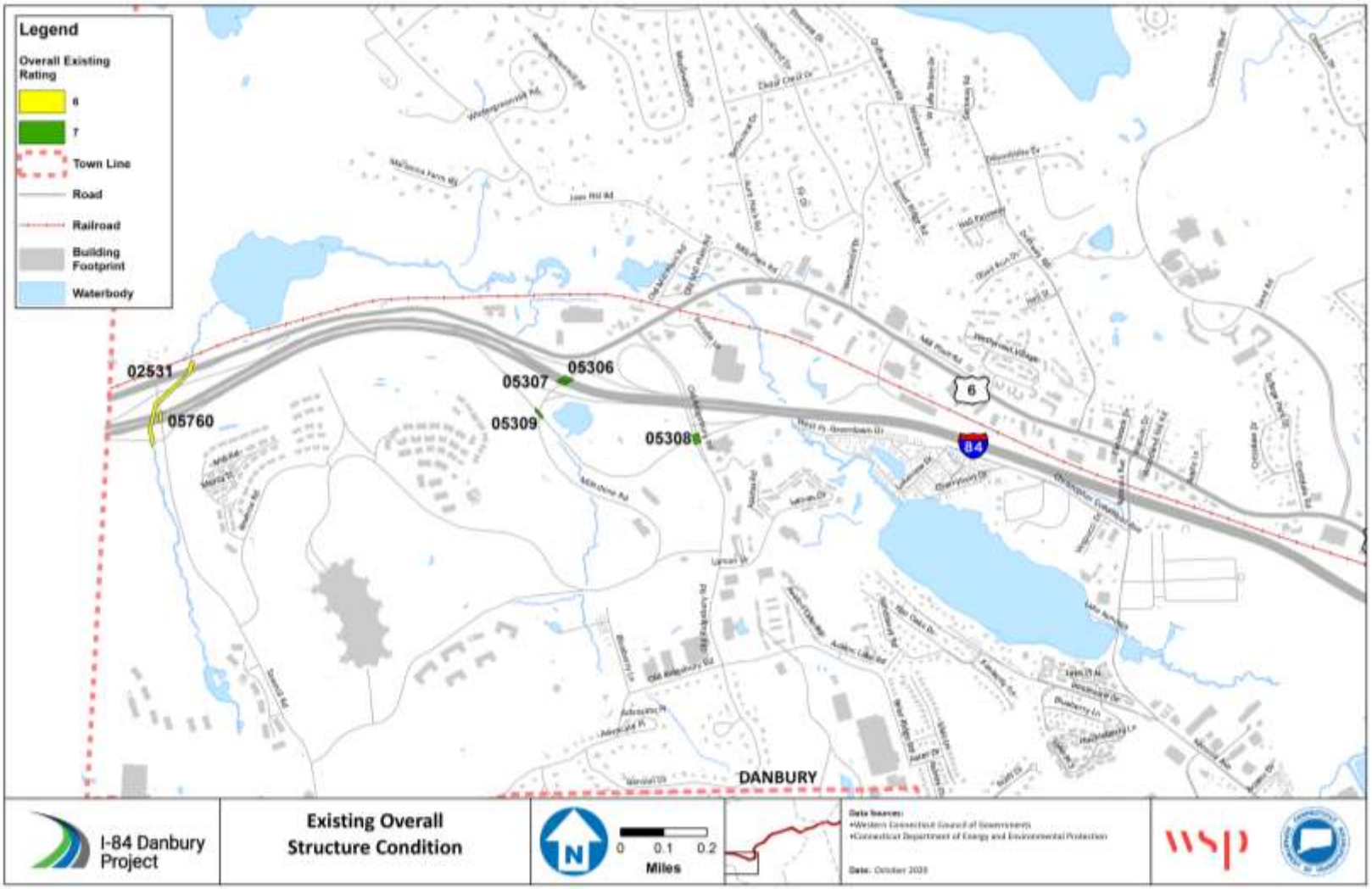

Figure 2-9
Existing Overall Structure Condition

2.5 Safety Analysis

2.5.1 Safety Overview

Crash data for I-84 Eastbound (EB) and Westbound (WB) from New York State Line to Interchange 2, and their respective termini locations within the study area were summarized from January 1, 2014 to December 31, 2016. The crash data was obtained from the University of Connecticut (UCONN) Crash Data Repository and was summarized by direction, location, type, contributing factor, severity, lighting conditions, and pavement conditions. During this period, a total of 188 crashes were reported, including 33 crashes that resulted in injuries. No fatality was reported. The crash data was broken down by direction, on/off-ramps or segments, and termini intersections, each with a crash rate expressed in crashes per million vehicle miles traveled (Crashes per MVMT).

There was a total of 188 crashes on I-84 in both the eastbound and westbound directions between New York State Line and Interchange 2 including segments, ramps and termini intersections. Of the 188 crashes on I-84, 126 crashes (approximately 67 percent) occurred on I-84 EB and the remaining 62 crashes (approximately 33 percent) occurred on I-84 WB. **Table 2-26** shows a breakdown of crashes by year between 2014 and 2016.

Table 2-26 I-84 – Crashes by Year

Direction	2014	2015	2016	Total
Eastbound	31	46	49	126
Westbound	23	27	12	62
Total	**54**	**73**	**61**	**188**

2.5.2 Eastbound Mainline

Of the 126 crashes on I-84 eastbound, 104 (approximately 83 percent) occurred on mainline segments.

Crash Rates

Table 2-27 shows the calculated crash rates on the mainline.

Table 2-27 I-84 Eastbound - Mainline Crash Rates

Segment From	Segment To	Number of Crashes	Crash Rate (MVMT)
Stateline	Interchange 1	0	0
Interchange 1	Interchange 2	104	1.54

Note: MVMT = Million Vehicle Miles of Travel

Due to the short distance between State Line and Interchange 1, no crash was reported between Stateline and Interchange 1. The segment crash rate scale is based on the CTDOT Unofficial 2015 Crash Rate for a classified road type, which is considered moderate ranging from 1.00 - 1.54 for the urban interstate. Given this reference range, the segments between Interchanges 1 and 2 is at the upper limit of this moderate crash rate.

CTDOT's 2018 Highway Safety Plan published statewide injury and fatality crash rates for 2015 expressed in hundred million vehicle miles of travel. Based on a million vehicles miles of travel,

the statewide injury rate is 1.14 and the fatality rate is 0.008. **Table 2-28** shows the injury and fatality crash rate for the I-84 eastbound mainline segments.

Table 2-28 I-84 Eastbound - Mainline Injury and Fatality Crash Rates

Segment From	Segment To	Number of Injuries	Number of Fatalities	Injury Crash Rate (MVMT)	Fatality Crash Rate (MVMT)
Stateline	Interchange 1	0	0	0.0	0.0
Interchange 1	Interchange 2	22	0	0.3	0.0

Note: MVMT = Million Vehicle Miles of Travel

As shown in Table 2-28, the injury and fatality crash rates on the I-84 segments are well below the statewide injury and fatality crash rates.

Severity

Of the 104 crashes reported, 82 (approximately 79 percent) were property damage only and 22 (approximately 21 percent) were injury related. No fatality was reported.

Types and Contributing Factors

As shown in **Figure 2-10,** the predominant crash type was rear-end crashes, followed by sideswipes and fixed objects. Of the 104 crashes reported, 64 (approximately 62 percent) were rear-end, 20 (approximately 19 percent) were sideswipes, 9 (approximately 9 percent) were fixed object and the remaining 11 (approximately 11 percent) were other types. Most of the rear-end crashes were reported due to vehicles improper passing or failing to keep in proper lane.

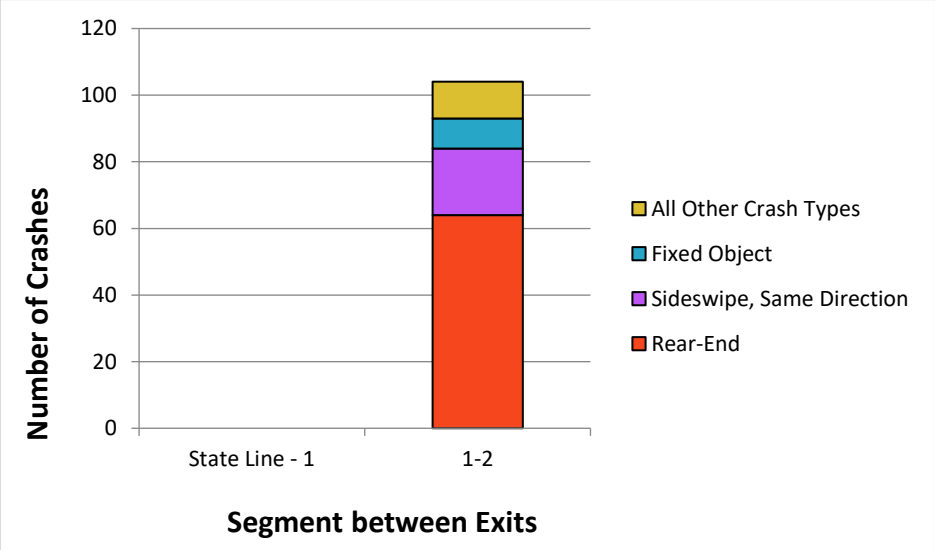

Figure 2-10
I-84 Eastbound – Mainline Crash Types

Trucks

Of the 104 crashes reported, medium to heavy trucks contributed to 16 crashes (approximately 15 percent).

Other Factors

Lighting is a concern between Interchanges 1 and 2 as 39 of the 104 crashes (approximately 38 percent) occurred during non-daylight hours.

2.5.3 Eastbound Ramps

Of the 126 crashes on I-84 eastbound, 12 (approximately 9 percent) occurred on ramp segments.

Crash Rates

A ramp crash rate scale was developed to compare individual crash rate at each ramp location with the average ramp crash rate that occurred within the study area. Based on this scale, ramp crash rates less than 6.25 were deemed satisfactory and crash rates above that were considered unsatisfactory. **Table 2-29** shows the I-84 eastbound ramp crash rates.

Table 2-29 I-84 Eastbound – Ramp Crash Rates

Number of Crashes	Crash Rate (MVMT)
0	0.00
0	0.00
7	2.06
2	3.81
3	2.71

As shown in Table 2-29, majority of the crashes occurred at the Interchange 2 off-ramp with seven (7) crashes (58 percent). However, the Interchange 2 on-ramp from Milestone Road and Interchange 2 On-ramp from Old Ridgebury Road locations has higher crasher rates (3.81 and 2.71 respectively) than Interchange 2 on-ramps. Overall, the crash rates on the I-84 EB ramp locations are well below the average ramp crash rate that occurred within the study area.

Severity

Of the 12 crashes reported, 10 (approximately 83 percent) were property damage only and 2 (approximately 17 percent) were injury related. No fatality was reported.

Types and Contributing Factors

Of the 12 crashes reported, 4 (approximately 33 percent) were rear-end, 2 (approximately 17 percent) were sideswipes, 2 (approximately 17 percent) were fixed object, and the remaining 4 (approximately 37 percent) were other and not applicable types.

As shown on **Figure 2-11**, rear-end crashes were predominant at Interchange 2 off-ramp due to vehicles were operated in reckless aggressive manner or drivers were inattentive manner following too closely. In addition, sideswipe, same direction crashes were predominant at Interchange 2 on-ramp (Old Ridgebury Road).

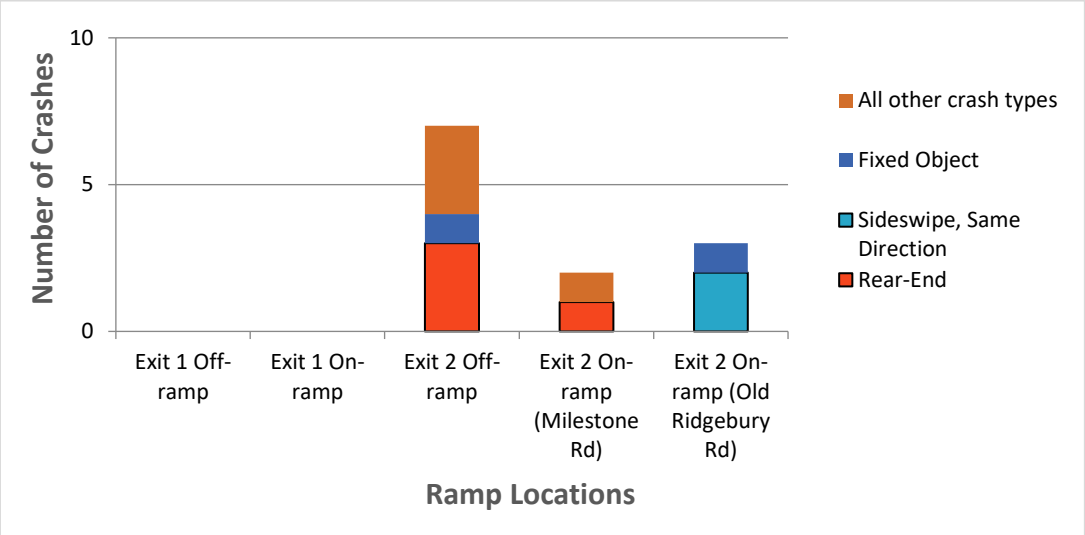

Figure 2-11
I-84 Eastbound – Ramp Crash Types

Trucks

At the Interchange 2 off-ramp, a total of three (3) truck related crashes were reported out of the 12 crashes (approximately 25 percent of the total). This was the most predominant location for truck crashes. Interchange 2 on-ramp (Old Ridgebury Road) had one (1) truck related crash and the rest area ramp locations had none.

Other Factors

9 of 12 ramp crashes (75 percent) occurred during dry pavement conditions, while the rest occurred during severe weather, such as snow and icy. Poor pavement condition was not a significant contributor to ramp crashes. However, 6 of 12 ramp crashes (50 percent) occurred during non-daylight hours. Key location is the Interchange 2 off-ramp where dark lighting is a major issue with 4 out of 7 crashes occurred during dark-lighted hours.

2.5.4 Eastbound Ramp Termini

Of the 126 crashes on I-84 eastbound, 10 (approximately 8 percent) occurred on ramp termini.

Crash Rates

The termini crash rate scale is based on the average termini crash rate for the corridor and it was determined that a crash rate over 0.99 is unsatisfactory.

Table 2-30 below shows crash rates for the three (3) ramp termini locations associated with ramps in the eastbound direction. Overall, the crash rates on the I-84 EB termini locations are well below the average termini crash rate that occurred within the study area.

Table 2-30 I-84 Eastbound – Ramp Termini Crash Rates

Intersection / Ramp Termini	Number of Crashes	Crash Rate (MEV)
Interchange 1 On/Off-ramp at Sawmill Rd	4	0.35
Interchange 2 On/Off-ramp at Milestone Rd	4	0.56
Interchange 2 On/Off-ramp at Old Ridgebury Rd	2	0.28

Severity

All the 10 crashes reported at the eastbound termini locations were property damage only. There were no fatalities or injuries reported at the ramp termini locations.

Types and Contributing Factors

Of the 10 crashes reported, 6 (60 percent) were rear-end, and the remaining 4 (40 percent) include angle, sideswipe same direction, other and not applicable types.

As shown on **Figure 2-12**, rear-end crashes were predominant at Interchange 2 on/off-ramp at Milestone Road due to vehicles failed to grant right-of-way.

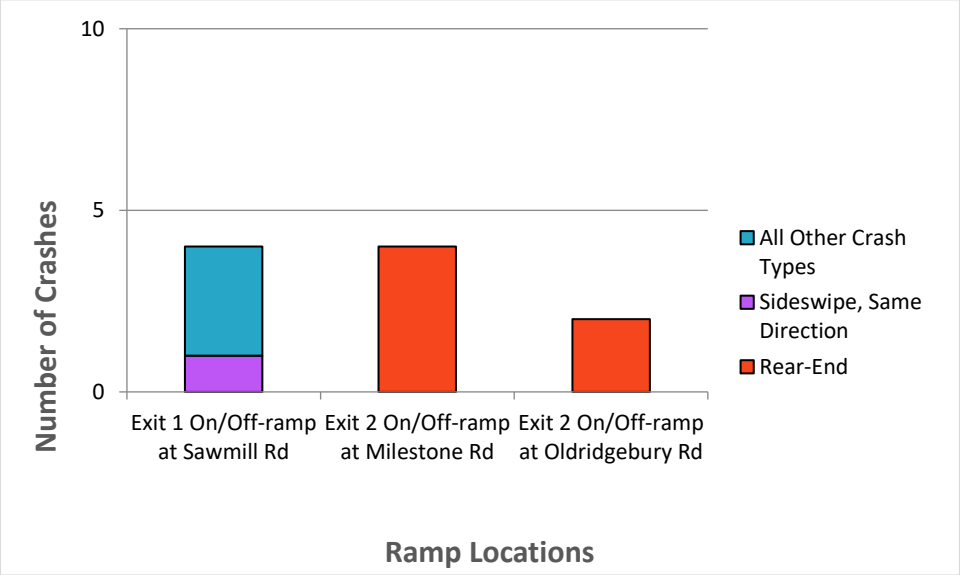

Figure 2-12
I-84 Eastbound – Ramp Crash Types

Trucks

Of the 10 crashes reported, large trucks were involved in 1 crash (10 percent).

Other Factors

There are no other factors which show a predominant cause of crashes.

2.5.5 Westbound Mainline

Of the 62 crashes on I-84 westbound, 34 (approximately 55 percent) occurred on mainline segments.

Crash Rates

Table 2-31 shows the mainline crash rates in the westbound direction.

Table 2-31 I-84 Westbound – Mainline Crash Rates

Segment From	Segment To	Number of	Crash Rate
State Line	Interchange 1	0	0
Interchange 1	Interchange 2	34	0.54

The segment crash rate scale is based on the CTDOT Unofficial 2015 Crash Rate for a classified road type, which is considered moderate ranging from 1.00 - 1.54 for the urban interstate. Given this reference range, Interchanges 1 to 2 is well below the lower limit of moderate rate. **Table 2-32** shows the injury and fatality crash rate for the I-84 westbound mainline segments.

Table 2-32 I-84 Westbound - Mainline Injury and Fatality Crash Rates

Segment From	Segment To	Number of Injuries	Number of Fatalities	Injury Crash Rate (MVMT)	Fatality Crash Rate (MVMT)
Stateline	Interchange 1	0	0	0	0
Interchange 1	Interchange 2	4	0	0.06	0.00

Note: MVMT = Million Vehicle Miles of Travel

As shown in Table 2-32, the injury and fatality crash rates on the I-84 segments are well below the statewide injury and fatality crash rates.

Severity

Of the 34 crashes reported, 30 (approximately 88 percent) were property damage only and the remaining four (12 percent) were injury related. No fatality was reported.

Types and Contributing Factors

Of the 34 crashes reported, 10 (approximately 29 percent) were sideswipes, 9 (approximately 26 percent) were rear-end, 9 (approximately 26 percent) were fixed object and the remaining 6 (approximately 18 percent) were other types.

Majority of the crashes occurring in the segment between Interchanges 1 and 2. The main contributing factors include improper passing, failed to keep in proper lane and following too closely. **Figure 2-13** shows the crash types for each of the mainline segment locations along I-84 in the westbound direction.

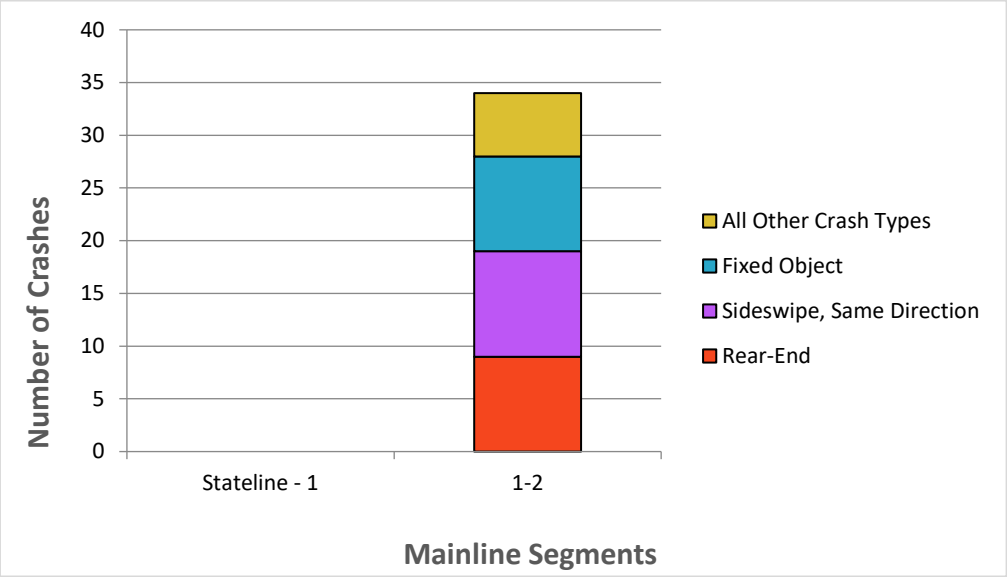

Figure 2-13
I-84 Westbound – Mainline Crash Types

Trucks

Of the 34 crashes reported, medium to heavy trucks contributed to 6 crashes (approximately 18 percent).

Other Factors

Lighting is a concern between segments 1 and 2 as 11 of 34 crashes (approximately 32 percent) occurred during dark-lighted hours.

2.5.6 Westbound Ramps

Of the 62 crashes on I-84 westbound, 9 (approximately 15 percent) occurred on ramp segments.

Crash Rates

Table 2-33 shows the ramp crash rates along I-84 in the westbound direction.

Table 2-33 I-84 Westbound – Ramp Crash Rates

Ramp Location	Number of Crashes	Crash Rate (MVMT)
Interchange 1 Off-ramp	2	1.59
Interchange 1 On-ramp	0	0.00
Interchange 2 Off-ramp	7	4.10
Interchange 2 On-ramp	0	0.00

For the I-84 WB exit ramp locations, the majority of the 9 crashes occurred at the Interchange 2 Off-ramp (7 crashes). Overall, the crash rates on the I-84 WB ramp locations are well below the average ramp crash rate that occurred within the study area.

Severity

Of the 9 crashes reported, 8 (approximately 89 percent) were property damage only and the remaining 1 (approximately 11 percent) was an injury related crash. No fatalities were reported on any of the westbound ramps.

Types and Contributing Factors

Of the 9 crashes reported, 3 (approximately 33 percent) were sideswipes, 2 (approximately 22 percent) were rear-ends, and the remaining 4 (approximately 45 percent) were other types. **Figure 2-14** shows the crash types for each of the ramp locations along I-84 in the westbound direction.

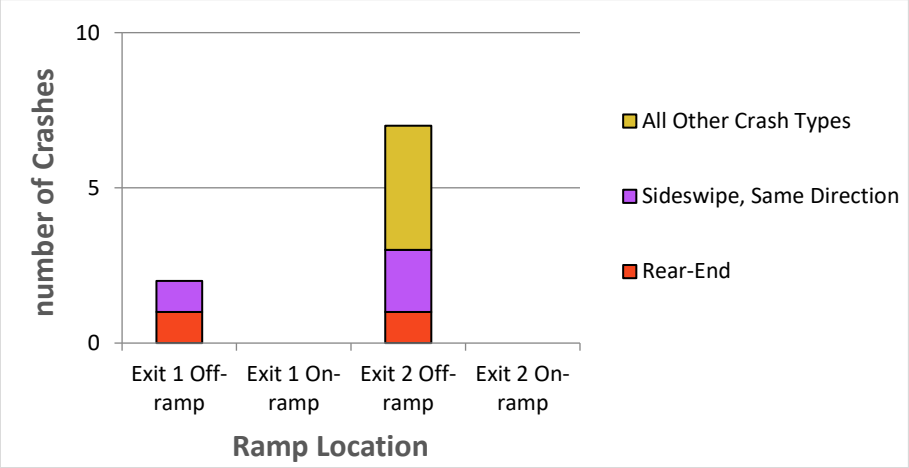

Figure 2-14
I-84 Westbound – Ramp Crash Types

Trucks

One (1) medium to large truck crash on Interchange 2 off-ramp (15 percent) was reported.

Other Factors

Lighting is a concern at Interchange 2 off-ramp as four (4) of the seven (7) crashes (approximately 57 percent) occurred during dark-lighted hours.

2.5.7 Westbound Ramp Termini

Of the 62 crashes on I-84 westbound, 19 (approximately 30 percent) occurred at the ramp termini locations.

Crash Rates

Table 2-34 below shows crash rates for the three (3) ramp termini locations associated with ramps in the westbound direction. The Interchange 1 on/off ramp termini with Sawmill Road is the predominant location among others relative to the number of crashes and the crash rate. This is mainly due to the short ramp length and high-volume traffic.

Table 2-34 I-84 Westbound – Ramp Termini Crash Rates

Intersection / Ramp Termini	Number of Crashes	Crash Rate (MEV)
Interchange 1 On/Off-ramp at Sawmill Rd	**13**	**1.32**
Interchange 2 On/Off-ramp at Milestone Rd	6	0.62
Interchange 2 On/Off-ramp at Old Ridgebury Rd	0	0

Severity

Of the 19 crashes reported at the westbound termini locations, 15 crashes (approximately 79 percent) were property damage only and the remaining 4 crashes (approximately 21 percent) were personal injury crashes. There were no fatalities reported at the ramp termini locations.

Types and Contributing Factors

Of the 13 crashes reported at the Interchange 1 ramp termini with Sawmill Road, 4 (approximately 31 percent) were rear-end, 3 (approximately 23 percent) were sideswipe in the same direction, 2 (approximately 15 percent) were fixed object, 1 (approximately 7 percent) was pedestrian related, and the remaining 3 (approximately 23 percent) were other types. Rear-end crashes were predominant due to following too closely at this location.

Of the 6 crashes reported at the Interchange 2 ramp termini with Sawmill Road, 4 (approximately 67 percent) were rear-end and the remaining 2 (approximately 33 percent) were other types.

Figure 2-15 shows the ramp termini crash rates along I-84 in the westbound direction.

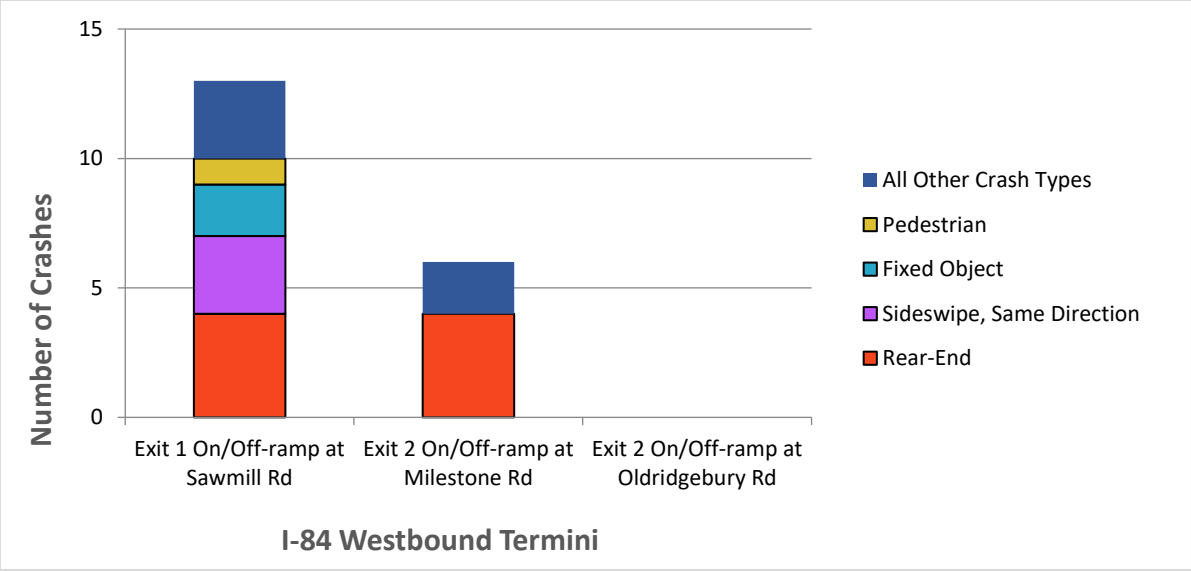

Figure 2-15
I-84 Westbound – Ramp Termini Crash Types

Trucks

No medium/heavy truck related crash was reported within I-84 WB ramp termini locations.

Other Factors

There are no other factors which show a predominant cause of crashes.

2.5.8 Summary of I-84 crashes

Below is a summary of I-84 crashes based on the data obtained on the most recent three-year period from 2014-16:

General

- Approximately 67 percent of crashes occurred in the eastbound direction.

Mainline Segments

- Rear-end crashes were predominant cause on I-84 eastbound direction, while in the westbound direction sideswipe, rear-end and fixed object crashes were significant.

Ramps

- Rear-end crashes were predominant cause at many ramp locations. However, sideswipe, same direction crashes were predominant at eastbound Interchange 2 on-ramp (Old Ridgebury Road) and westbound Interchange 2 off-ramp.

Termini

- High crash rates at the Interchange 1 on/off ramp at Sawmill Road termini in the westbound direction.
- One (1) pedestrian related crash reported at the Interchange 1 on/off ramp at Sawmill Road termini in the westbound direction.
- Rear-end crashes were predominant cause at termini locations.

Figure 2-16 shows the summary of I-84 crashes.

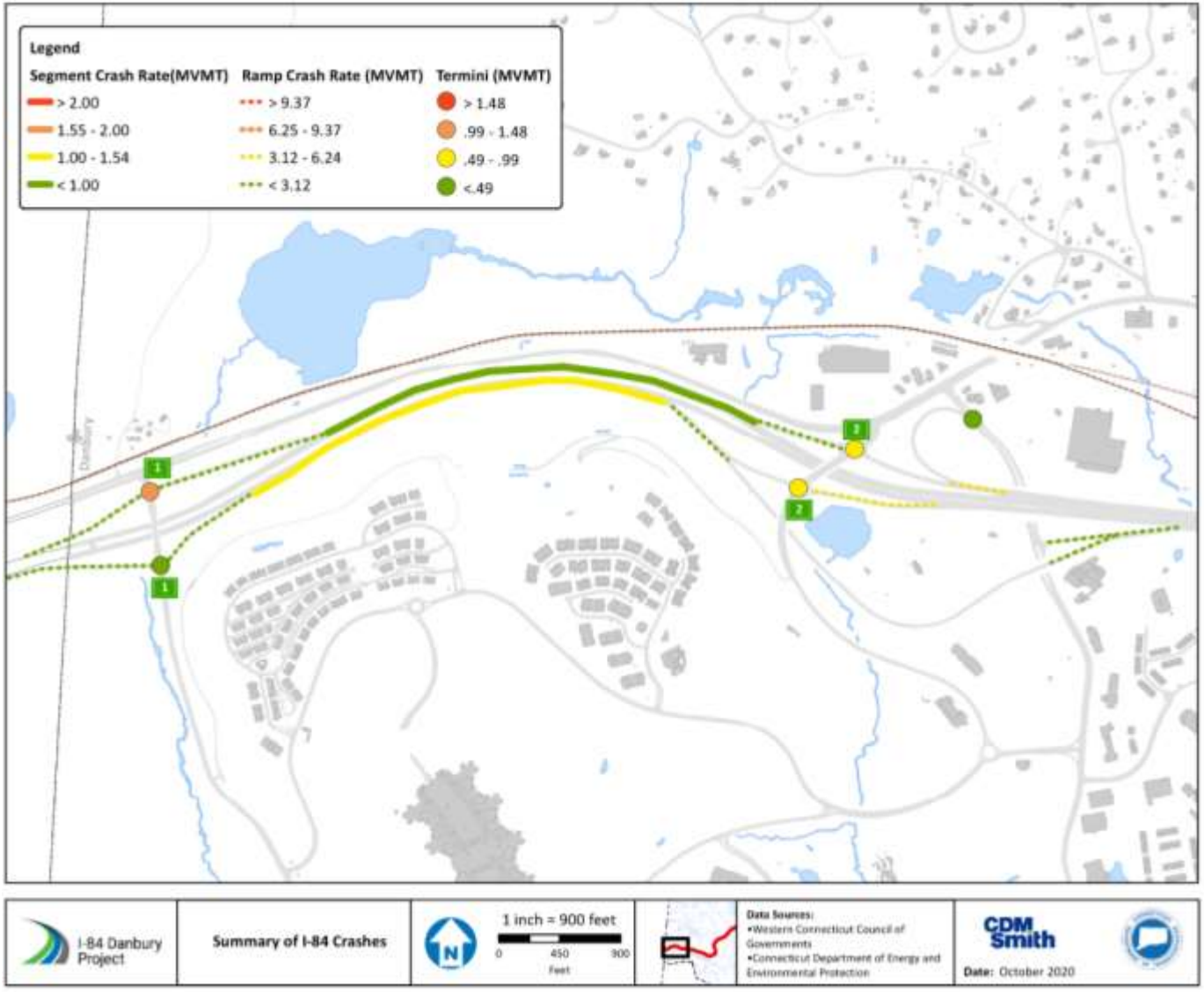

Figure 2-16
Summary of I-84 Crashes

CDM Smith

2.6 Multimodal Transportation

The Needs and Deficiencies Report dated October 2018 includes the following sections pertinent to multimodal transportation in the study area:

- **Section 2.7.12 – Rail Transit**
- **Section 2.7.13 – Travel Demand Management**

Therefore, they are not covered in this report.

2.6.1 Land Uses That Generate or Attract Pedestrians and Bicyclists

The street network on the west side of Danbury is characterized by only a handful of arterials and collector streets. The most notable arterial is Mill Plain Road (U.S. Route 6/State Route 202) which parallels I-84, just north of the highway. This east-west arterial is an important commercial street that serves the region. In the 3.5-mile distance between the New York state line and Interchange 3 in Danbury, there are only four streets that cross I-84 and connect the west side of Danbury with Mill Plain Road and the northwestern area of Danbury. They include Saw Mill Road at interchange 1, Milestone Road at interchange 2, Old Ridgebury Road at interchange 2A, and Kenosia Avenue. None of these cross streets are suitable for pedestrian or bicycle travel as they do not have sidewalks or bicycle lanes, and shoulders on these streets are not adequate for bicycle travel.

This lack of pedestrian and bicycle infrastructure on the west side does not necessarily indicate that there is a lack of demand for pedestrian and bicycle travel. The western section of I-84 in Danbury (between Interchanges 1 and 3) does not have the density or diversity of land uses as sections of I-84 closer to Downtown Danbury (e.g. the west side of Danbury does not have transit-oriented development, public schools, hospitals, or housing for the aged within one-half mile of I-84); also, residents of west side neighborhoods are less transit-dependent. Nonetheless, there are many land uses on the west side that generate or attract pedestrians and bicyclists and that would benefit from improvements to the multimodal network. **Figure 2-17** provides an overview of various non-residential land use categories in the study area; it has been updated to show these land uses within the west side of Danbury.

- **Commercial Development:** Mill Plain Road provides access to many stores and businesses, including hotels, supermarkets, banks, medical clinics, medical offices, and restaurants. There are no bicycle lanes on Mill Plain Road, but the road has sidewalks along some of its length. There are also three hotels on or near Old Ridgebury Road (Interchange 2A) just south of I-84.
- **Major Employers:** There are many large businesses and corporate headquarters located on the south side of I-84 within one-half mile of the interstate including the Matrix center on Reserve Road and Belimo on Turner Road, both accessed from Saw Mill Road (Interchange 1), Ridgebury Corporate Center and Lansing Building Products on Old Ridgebury Road, and Hologic and Cartus on Apple Ridge Road. In addition, U.S. Boehringer-Ingelheim Pharmaceuticals, Inc. has a sprawling campus on the Danbury-Ridgefield town

line; it is accessed from Briar Ridge Road via Old Ridgebury Road and is one mile south of I-84.

- **Multi-family Residential Development:** Most of the residential development in the west side of Danbury is comprised of single-family homes, however, there are numerous, recently constructed, multifamily developments that contain hundreds of dwelling units, including Westwoods Village Condominiums on the north side of I-84 on Mill Plain Road. Multifamily homes on the southside of I-84 include The Rivington townhomes and condominiums on Reserve Road which parallels I-84 between Interchanges 1 and 2, Crown Point Apartments, Mayfair Square, and Abbey Woods off of Saw Mill Road (Interchange 1), Kensington Woods off Old Ridgebury Road (Interchange 2A), and the Lakeview mobile home community on Christopher Columbus Avenue, off of Kenosia Avenue. Other nearby multifamily developments south of I-84 include Briar Woods apartments and Willow Grove Apartment Homes on Briar Ridge Drive which connects to Old Ridgebury Road (Interchange 2A), and Lake Place Condominiums on Boulevard Drive which connects to Kenosia Avenue. Many hundreds more multifamily dwellings are proposed in the west side, including on the Reserve located on Reserve Road and Woodland Road off of Saw Mill Road.

- **Schools and Universities:** There are a few educational institutions on the west side of Danbury within on-half mile of I-84. The Westside Middle School Academy on School Ridge Road off of Lakeview Avenue Extension (U.S. Rt. 6/ State Rt. 202) is located near Interchange 3 of I-84. This public middle school (one of three middle schools in Danbury) has about 250 students in grades 6-8. Mill Ridge Primary School is a public elementary school (grades K-3) on Mill Ridge Road adjacent to the Westside Middle School Academy near Interchange 3. Western Connecticut State University's (WCSU) Westside Campus is located on University Boulevard off Lake Avenue Extension (U.S. Rt. 6/ State Rt. 202) between Interchanges 2 and 3 of I-84. This 364-acre campus combined with WCSU's main campus in downtown Danbury, accommodate over 5,600 full- and part-time students from across the region. WCSU is principally a commuter college. Western Connecticut Academy for International Studies is an elementary magnet school located on University Boulevard adjacent to WCSU's Westside Campus. Also, the Wooster School, a private preparatory academy of over 330 students (grades 4-12), is located on a 127-acre campus on Miry Brook Road, about a mile south of the interstate. Students travel to this academy from 22 nearby Connecticut towns and cities and from 26 towns and cities in New York State.

- **Parks:** There are two public parks located within a few hundred feet of I-84 between Interchanges 1 and 3 in Danbury. Farrington Woods is a 200-acre open space owned by the City of Danbury. The park is on the north side of I-84 on the CT-NY border. It is accessed from Mill Plain Road just west of its intersection with Saw Mill Road (Interchange 1). This park has 6 to 8 miles of trails and is a very popular destination for hikers and mountain bikers. Lake Kenosia Park is a 25-acre park owned by the City of Danbury that includes picnic areas, a spray park, non-motorized boating, and four soccer fields. It is located on Christopher Columbus Avenue, off of Kenosia Avenue, just south of and directly adjacent to I-84.

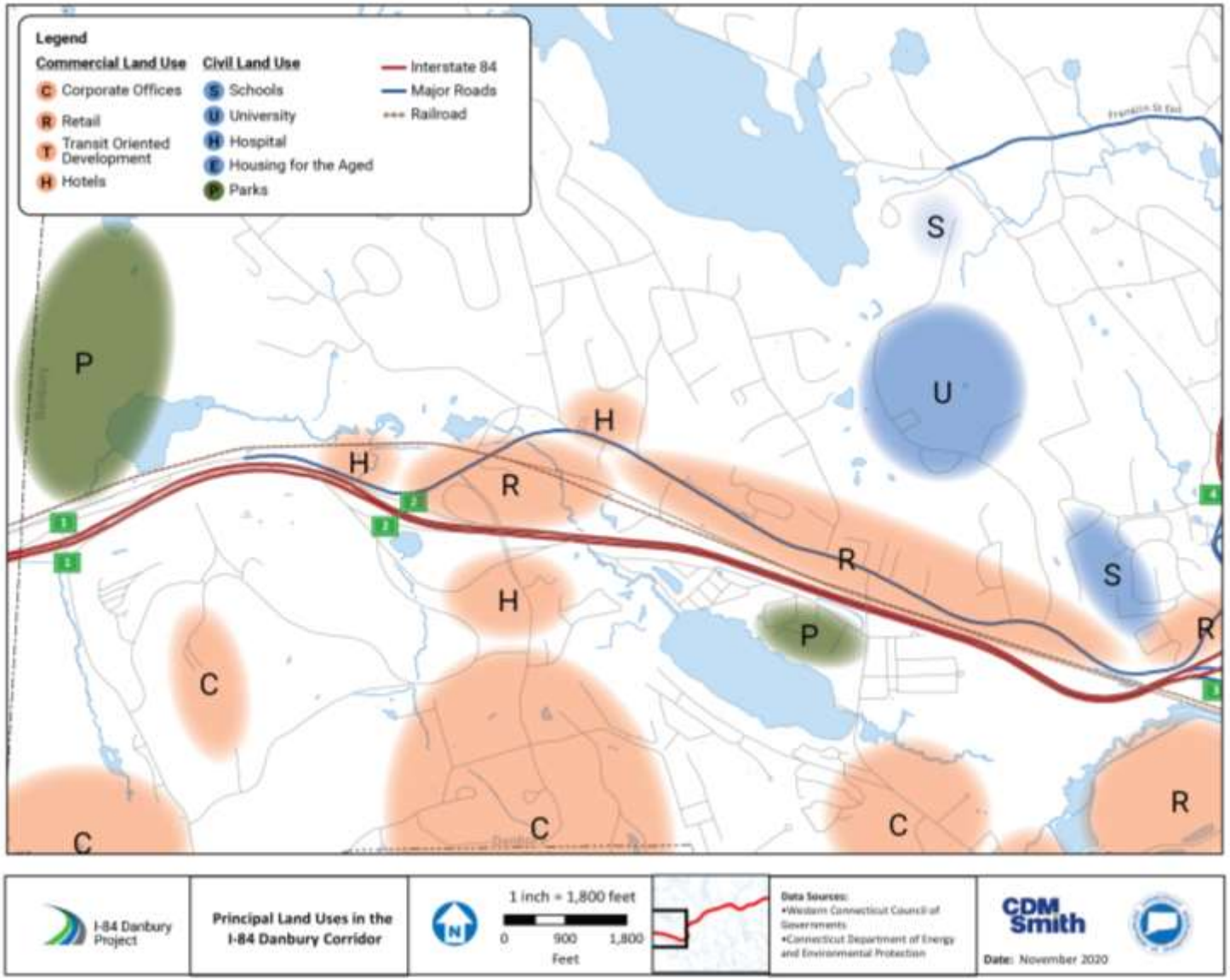

Figure 2-17
Principal Non-Residential Land Uses in the I-84 Danbury Corridor

2.6.2 Pedestrian and Bicycle Desire Lines and Gaps

There are four municipal streets that cross I-84 between the New York State line and Interchange 3 in Danbury, they include Saw Mill Road at Interchange 1, Milestone Road at Interchange 2, Old Ridgebury Road at Interchange 2A, and Kenosia Avenue. All but Kenosia Avenue have Interchanges with I-84. Saw Mill Road and Milestone Road travel under I-84, while Old Ridgebury Road and Kenosia Avenue travel over I-84. Mill Plain Road (U.S. Route 6/State Route 202) parallels I-84, just north of the highway. Saw Mill Road and Mill Plain Road are classified as "Minor Arterials;" Old Ridgebury Road and Kenosia Avenue are classified as "Major Collector" roads; and Milestone Road is unclassified.

Each of these four cross streets connect significant multifamily residential development, hotels and major corporate employers located on the south side of I-84 with significant commercial development located along Mill Plain Road and Lake Avenue Extension (U.S. Rt. 6/ State Rt. 202) on the north side of the highway. They also provide connections to several educational institutions and two public parks on the west side of Danbury. Therefore, each cross street represents an important pedestrian-bicycle desire line. In the context of this study, a pedestrian-bicycle desire line is the most direct or desirable route between significant pedestrian or bicycle generators and significant pedestrian or bicycle destinations. These desire lines are depicted in **Figure 2-18**.

As discussed in the previous section, there is a lack of pedestrian and bicycle infrastructure on west side streets. In the vicinity of Interstate 84, there are no streets that provide bicycle lanes or road shoulders that are adequate for bicycle travel. Also, few of the streets have sidewalks. This lack of pedestrian and bicycle infrastructure is especially noticeable on Mill Plain Road because of the density of commercial development and the intensity of traffic. Also, because the network of streets on the west side is relatively sparse, there are fewer opportunities for safe and convenient non-motorized travel.

On the four municipal streets that cross I-84, three have Interchanges with I-84 – Saw Mill Road, Milestone Road and Old Ridgebury Road. The intersections of these streets with the various highway on- and off-ramps are particularly daunting for pedestrians and bicyclists because: a) the traffic on the ramps is relatively intensive and high speed; b) the intersections have very broad radii that encourage high speed turns increase pedestrian crossing distances; c) there are no crosswalks at the ramps; d) lighting at the intersections and on the underside of adjacent highway bridges is minimal or nonexistent; and, e) there are no sidewalks or bicycle lanes.

Further, the I-84 Interchanges at Saw Mill Road (Interchange 1), Milestone Road (Interchange 2), and Old Ridgebury Road (Interchange 2A) all lie within 200 feet of Mill Plain Road. None of these signalized intersections, all of which have four or more travel lanes on each leg, have crosswalks or adequate lighting to accommodate pedestrian travel. These conditions represent barriers to pedestrian and bicycle travel because they hinder or discourage walking and bicycling due to a lack of safety accommodations, relatively high traffic speeds, non-existent crosswalks, and poor lighting.

Eliminating or reducing these barriers to pedestrian and bicycle travel on streets that cross I-84 and at intersections of local streets with highway ramps and at cross streets with Mill Plain Road and Lake Avenue Extension (U.S. Rt. 6/State Route 202) will improve travel safety and reduce

travel demand by single-occupant automobiles in the study area. Improvements in non-motorized travel in the study area can also improve connectivity to transit by making it easier and safer for pedestrians and bicyclists to travel from their homes, schools, or places of employment to nearby bus stops.

2.6.3 HART Fixed Route Bus Service

Bus transit within the expanded study limits (i.e. Interchange 1 at New York State line to Interchange 3) is run by Housatonic Area Rapid Transit (HART). Three bus routes serve the expanded study limits on Danbury's west side (refer to **Figure 2-19**): the 3 Route, Mill Plain Road – Brewster; the 6 Route, Danbury Mall – Lake Avenue; and the new 10 Route, The Reserve Commuter Connection Old Ridgebury Road.

The 3 Route extends from HART's pulse point in downtown Danbury to the MetroNorth commuter rail station in Brewster, New York. Within the expanded study limits, this route principally uses Lake Avenue Extension and Mill Plain Road. Main stops in the study limits include Mill Ridge Road, the Danbury Green shopping center on Mill Plain Road at Interchange 2 (Starbucks and Trader Joes), and the Interchange 2 park-and-ride lot on Mill Plain Road. Stops are also provided on a part-time basis to the Jensen Park mobile home community on Christopher Columbus Avenue, and to the Matrix facility via Old Ridgebury Road and Woodland Road.

The 6 Route extends from downtown Danbury to the Danbury Fair Mall. Principal stops within the expanded study limits include Mill Ridge Road, the Danbury Fair Mall and the adjacent Danbury Square Mall on Backus Avenue at Kenosia Avenue. On a part-time basis, service is extended to Apple Ridge Road (Cartus and Hologic facilities) and to the Jenson Park mobile home community on Christopher Columbus Avenue.

The 10 Route is a new commuter service that operates entirely within the west side of Danbury. The 10 Route is a pilot circulator program between the park-and-ride lot at Interchange 2 (where riders can transfer to the 3 Route) and points south, including major employers (the Matrix, the Reserve, and Bolimo) and several new multifamily developments and hotels (refer to Updated Exhibit 2-69). The route operates as a micro-transit/on demand service using small buses under a contract with TransLoc. Riders can request a ride using a mobile app and buses are dispatched to pre-determined locations. Real-time rider communications and tracking notifies riders of bus locations and arrival times. The app also allows riders to pay for their rides ahead of time directly in the app.

Since the 2018 Needs and Deficiency Study was published, HART has changed some of its fixed routes and commuter shuttles routes and schedules because increasing traffic congestion result in travel delays that affect riders' ability to make timed transfers. The delays are especially intense during PM peak hours and some weekend hours, and on Routes that use Lake Avenue Extension and Mill Plain Road in Danbury's west side. In fact, some HART shuttles now utilize I-84 instead of Mill Plain Road/Lake Avenue Extension and later evening and Sunday routes operate on slightly different and more efficient routes than the daytime routes. Another recent change is that the Danbury-Norwalk Route 7Link route was significantly modified as a reaction to ridership decreases and operational changes initiated by the Norwalk Transit District.

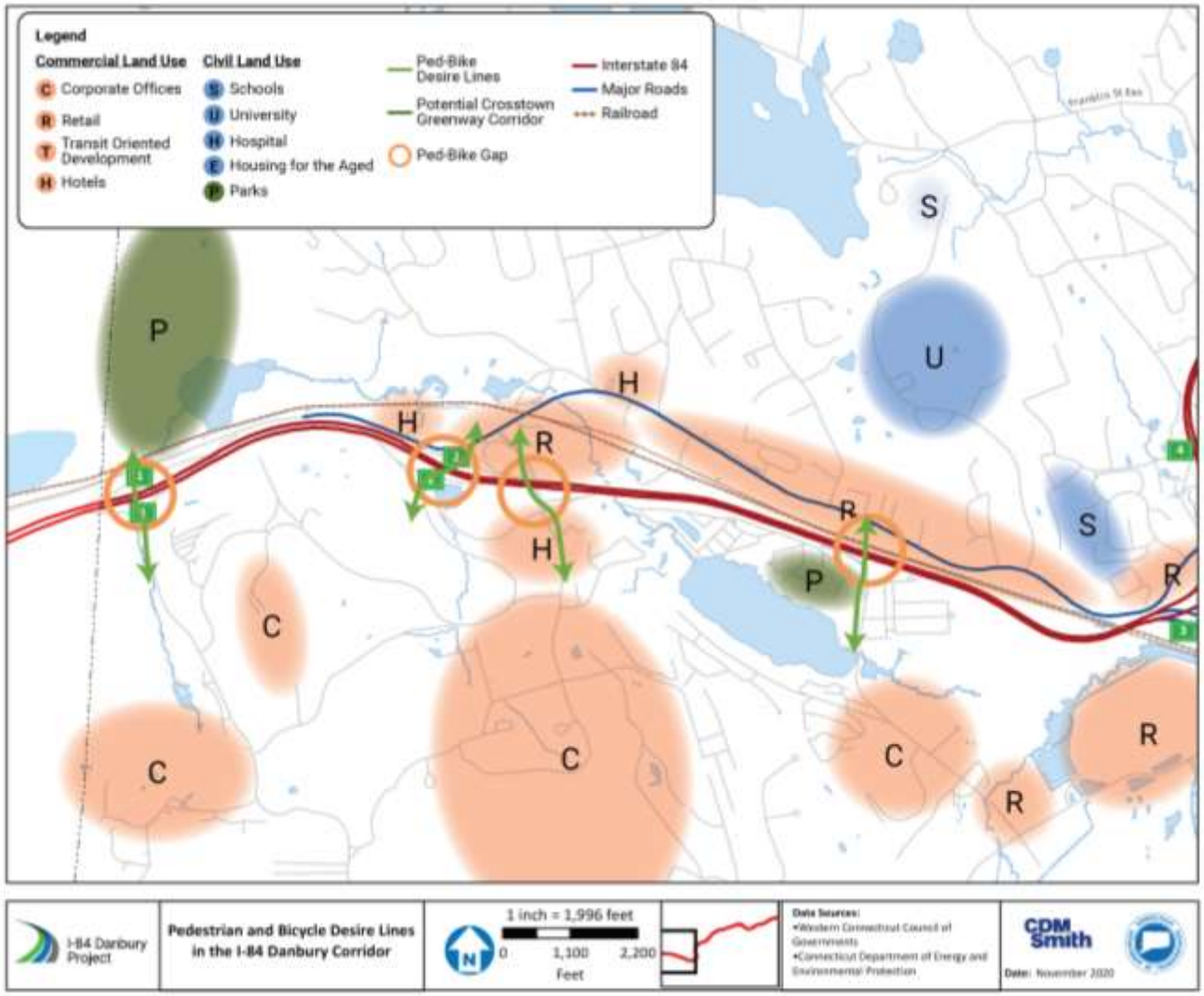

Figure 2-18
Pedestrian and Bicycle Desire Lines in the I-84 Danbury Corridor

CDM Smith

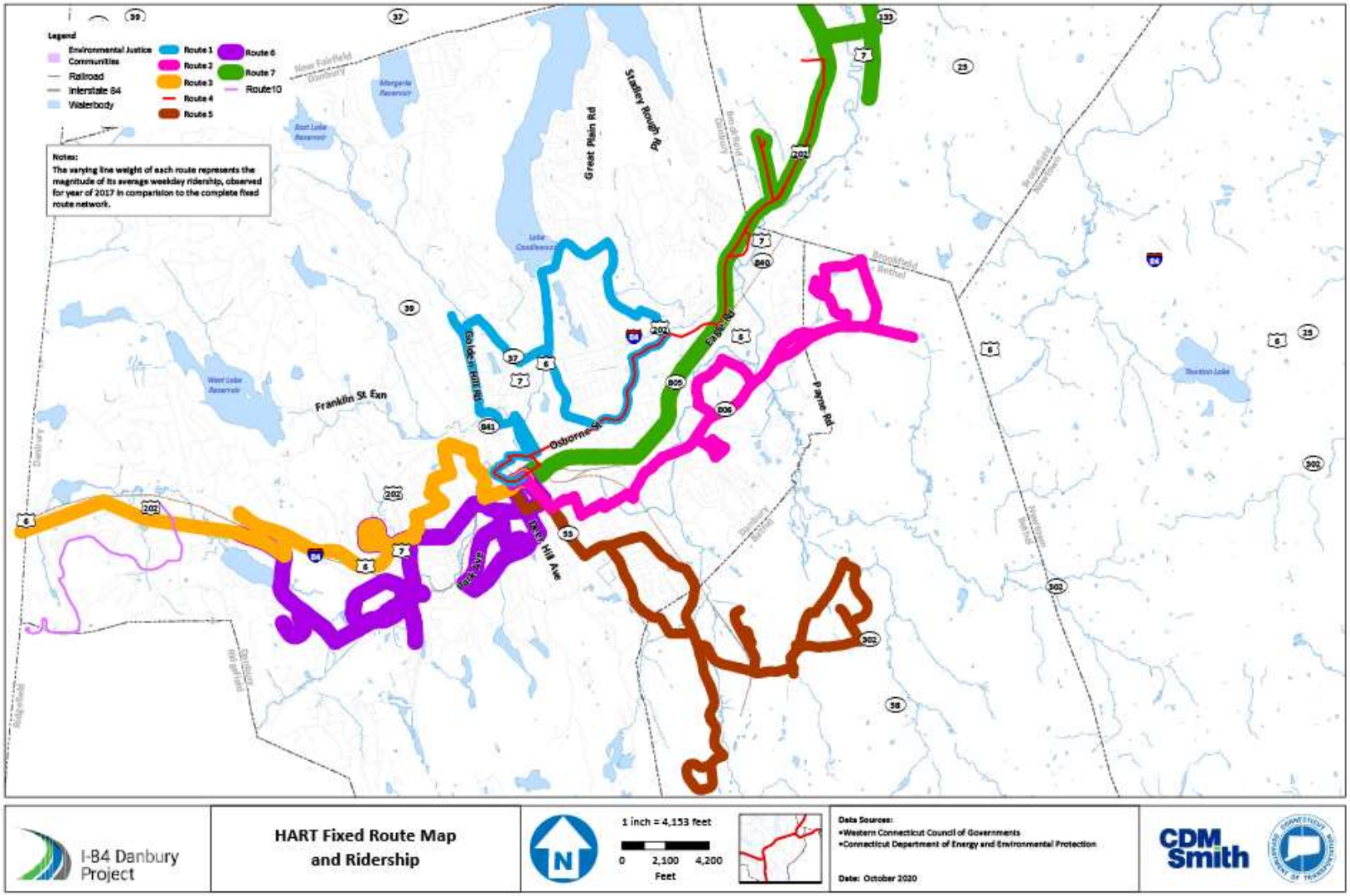

Figure 2-19
HART Fixed Route Map and Ridership

Section 3

Future Transportation Conditions

The Needs and Deficiencies Report dated October 2018 includes the analysis of the future transportation conditions from the Kenosia Avenue bridge over I-84 easterly to Interchange 8 on I-84**. This section supplements the future transportation conditions on I-84 from the vicinity of the New York State line easterly to the Kenosia Avenue bridge over I-84.**

3.1 Future (2040) No Build Traffic Volumes

Table 3-1 presents a comparison of existing and future traffic volumes on I-84.

Table 3-1 I-84 Traffic Volumes – Existing vs. Future

Eastbound	2016			2040		
	Daily	AM	PM	Daily	AM	PM
New York Line and Interchange 1	37,000*	1,730	3,240	46,500	2,180	4,070
Interchange 1 and Interchange 2	35,000*	1,730	3,100	44,100	2,180	3,900
Interchange 2 and Interchange 3	38,800	1,820	3,510	46,000	2,240	4,210
Westbound	**2016**			**2040**		
	Daily	AM	PM	Daily	AM	PM
New York Line and Interchange 1	27,000*	2,400	2,530	33,500	2,880	3,150
Interchange 1 and Interchange 2	33,000*	2,950	2,540	40,900	3,560	3,160
Interchange 2 and Interchange 3	42,400	3,750	2,650	48,000	4,390	3,200

Note: * - Estimated based on peak hour traffic volumes.
Source: CDM Smith.

3.2 Network Performance Measures

This section discusses the network performance measures. These measures were updated for the study corridor based on the extended study limits.

3.2.1 Definitions of Performance Measures

Performance measures are metrics which are used to determine the effectiveness of a specific improvement strategy or alternative. The following is a list and definition of network performance measures used in the VISSIM analysis:

- **Total distance traveled or Vehicle Miles Traveled (VMT)** – The total distance traveled by all vehicles that completed their trips in the designated time period. This is measured for

the entire network. A higher VMT is considered good, as it means that drivers are able to travel further within a given period of time.

- **Total travel time or Vehicle Hours Traveled (VHT)** – The total travel time experienced by all vehicles that completed their trips in the designated time period. This is measured for the entire network. A lower VHT is considered good, as it means drivers are spending less time waiting at signals/stop signs and there is less stop-and-go driving.
- **Average speed (in miles per hour)** – Travel speed averaged over all vehicles that completed their trips in the designated time period. This is measured for the entire network (and includes when drivers are stopped at signals and stop signs). A higher speed is considered good, as it means vehicles are moving efficiently through the intersections and along the corridor. In the model, the maximum speed a vehicle can achieve on any portion of the corridor is the desired speed. The desired speed is a function of the posted speed limit and varies for each vehicle based on driver comfort and travel conditions.
- **Average delay time (in seconds per vehicle)** – The delay time is the additional time incurred by a vehicle when the travel speed drops below the free-flow speed of the facility. When the delay time is averaged over the number of vehicles in the roadway system, the average delay time is computed. A lower average delay time is considered as good, as it means the vehicles are not experiencing frequent speed reductions.
- **Number of stops** – The total number of stops experienced by vehicles traveling on a facility. Fewer stops are good as vehicles travel unimpeded.
- **Total stopped delay (in vehicle hours)** – The amount of delay experienced by vehicles under a stopped condition measures in vehicle hours. A lower stopped delay is considered good, as it means drivers are spending less time stopping on a facility and do not incur waiting time or delay.

3.2.2 Quantitative Performance Measures

- **Existing (2016)** – This condition represents current traffic volumes under the current roadway network.
- **Future (2040) No Build** – This condition represents future (2040) no build traffic volumes under the current roadway network.

Table 3-2 presents a comparison of existing and future no build network performance measures during the A.M. and P.M. peak hour periods.

Table 3-2 Network Performance Measures

Description	Unit	Existing (2016)	Future No Build (2040)	Difference (%)
AM Peak Hour				
Total Distance Traveled	mi	110,876	116,128	+5%
Total Travel Time	h	3,027	3,506	+16%
Average Speed	mph	37	33	-10%
Average Delay Time per Vehicle	sec	82	102	+25%
Number of Stops	ea	89,910	142,412	+58%
Total Stopped Delay	h	271	453	+67%
PM Peak Hour				
Total Distance Traveled	mi	121,440	124,956	+3%
Total Travel Time	h	3,317	4,736	+43%
Average Speed	mph	37	26	-28%
Average Delay Time per Vehicle	sec	72	143	+99%
Number of Stops	ea	59,861	269,780	+351%
Total Stopped Delay	h	210	709	+237%

The following are some of the key observations:

- **Total distance traveled or Vehicle Miles Traveled (VMT)** – The VMT increases by about 5 percent (110,2876 vehicle miles under existing to 116,128 vehicle miles under the future no build condition) during the A.M. peak hour period and by about 3 percent (121,440 vehicle miles under existing to 124,956 miles under the future no build condition) during the P.M. peak hour period. This shows an improvement in VMT.

- **Total travel time or Vehicle Hours Traveled (VHT)** – The VHT increases by about 16 percent (3,027 vehicle hours under existing to 3,506 vehicle hours under the future no build condition) during the A.M. peak hour period and by about 43 percent (3,317 vehicle hours under existing to 4,736 vehicle hours under the future no build condition) during the P.M. peak hour period. This shows deterioration in VHT.

- **Average speed (in miles per hour)** – The average speed decreases by about 10 percent (37 miles per hour under existing to 33 miles per hour under the future no build condition) during the A.M. peak hour period and by about 28 percent (37 miles per hour under existing to 26 miles per hour under the future no build condition) during the P.M. peak hour period. This shows deterioration in average speed.

- **Average delay time (in seconds per vehicle)** – The average delay per vehicle increases by about 25 percent (82 seconds under existing to 102 seconds under the future no build condition) during the A.M. peak hour period and by about 99 percent (72 seconds under existing to 143 seconds under the future no build condition) during the P.M. peak hour period. This shows deterioration in average delay time.

- **Number of stops** – The number of stops increases by about 58 percent (89,910 under existing to 142,412 under the future no build condition) during the A.M. peak hour period and by about 351 percent (59,861 under existing to 269,412 under the future no build condition) during the P.M. peak hour period. This shows deterioration in number of stops.

- **Total stopped delay** – The total stopped delay increases by about 67 percent (271 vehicle hours under existing to 453 vehicle hours under the future no build condition) during the A.M. peak hour period and by about 237 percent (210 vehicle hours under existing to 709 vehicle hours under the future no build condition) during the P.M. peak hour period. This shows deterioration in total stopped delay.

3.3 Future (2040) Levels of Service Analysis

This section discusses the levels of service analysis under future (2040) conditions for the mainline segments, mainline-ramp junctions, weaving segments, and the intersections for the extended study limits.

3.3.1 Mainline Segment Operations

Tables 3-3 and **3-4** shows levels of service (LOS) analysis results for I-84 mainline segments in the eastbound and westbound directions respectively This condition is anticipated to deteriorate in the future and the listed mainline segment noted below will operate at LOS E or F.

Eastbound Direction

- Between Interchange 2B On and Interchange 3 Off Ramps.

Westbound Direction

- None.

3.3.2 Mainline Ramp Junction Operations

Tables 3-5 and **3-6** show level of service (LOS) analysis results for I-84 merge and diverge ramp segments in the eastbound and westbound directions respectively under during the weekday A.M. and P.M. peak hour periods. No ramp segments are anticipated to operate at LOS of E or F under future conditions.

3.3.3 Intersection Operations

Table 3-7 shows the level of service (LOS) analysis results for signalized future (2040) conditions during the weekday A.M. and P.M. peak hour periods. *The following is a list of intersections where a specific movement operates at a volume to capacity (v/c) ratio greater than 1.0 and a LOS E or F under future conditions:*

- **Danbury Road/ Mill Plain Road (US 6/202) at Saw Mill Road**– This intersection is anticipated to operate at an overall LOS D and C during the weekday A.M. and P.M. peak hour periods respectively. During the A.M. peak hour period, several movements operate at LOS E or worse i.e. Mill Plain Road westbound left turn and Mill Plain Road westbound through. All v/c ratios are less than 1.0.

Table 3-3 Future (2040) I-84 Segment Levels of Service – Eastbound Direction

Location			Weekday A.M. Peak			Weekday P.M. Peak		
Start	End	Length (ft)	Volume	Density (pc/mi/ln)	LOS	Volume	Density (pc/mi/ln)	LOS
Interchange 1 Off **To Saw Mill Road**	Interchange 1 On **From Saw Mill Road**	2,000	1940	15.4	B	3640	26.3	D
Interchange 1 On **From Saw Mill Road**	Interchange 2 Off **To Milestone Road**	2,770	2180	11.2	B	3900	18.6	C
Interchange 2 Off **To Milestone Road**	Interchange 2A On **From Milestone Road**	2,820	1670	13.4	B	3310	24.6	C
Interchange 2A On **From Milestone Road**	Interchange 2B On **From Old Ridgebury Road**	1,570	1750	9.5	A	3520	17.5	B
Interchange 2B On **From Old Ridgebury Road**	Interchange 3 Off **To Route 7 Southbound**	8,600	2240	11.8	B	4210	44.9	E

Table 3-4 Future (2040) I-84 Segment Levels of Service – Westbound Direction

Location			Weekday A.M. Peak			Weekday P.M. Peak		
Start	End	Length (ft)	Volume	Density (pc/mi/ln)	LOS	Volume	Density (pc/mi/ln)	LOS
Interchange 1 Off **To Saw Mill Road**	Interchange 1 On **From Saw Mill Road**	3,190	2670	21.9	C	2910	25.3	C
Interchange 2 On **From Milestone Road**	Interchange 1 Off **To Saw Mill Road**	2,450	3560	18.9	C	3160	16.7	B
Interchange 2 Off **To Milestone Road**	Interchange 2 On **From Milestone Road**	2,970	3250	17.5	B	2540	14.5	B
Interchange 3 On **From Route 7 Northbound**	Interchange 2 Off **To Milestone Road**	9,790	4390	20.6	C	3200	15.9	B

Table 3-5 Future (2040) I-84 Ramp Levels of Service – Eastbound Direction

Location	Weekday AM Peak				Weekday PM Peak			
	Volume				Volume			
	Mainline	Ramp	Density (pc/mi/In)	LOS	Mainline	Ramp	Density (pc/mi/In)	LOS
Interchange 1 – Saw Mill Road								
Off Ramp	2180	240	11.4	B	4070	430	20.1	C
On Ramp	1940	240	11.1	B	3640	260	18.0	B
Interchange 2 – Milestone Road								
Off Ramp	2180	510	11.3	B	3900	590	19.1	B
Milestone Road - On Ramp	1670	80	9.5	A	3310	210	17.5	B
Old Ridgebury Road - On Ramp	1750	490	8.3	A	3520	690	14.9	B

Table 3-6 Future (2040) I-84 Ramp Levels of Service – Westbound Direction

Location	Weekday AM Peak				Weekday PM Peak			
	Volume				Volume			
	Mainline	Ramp	Density (pc/mi/In)	LOS	Mainline	Ramp	Density (pc/mi/In)	LOS
Interchange 1 – Saw Mill Road								
On Ramp	2670	210	15.2	B	2910	240	17.7	B
Off Ramp	3560	890	20.8	C	3160	250	18.2	B
Interchange 2 – Milestone Road								
On Ramp	3250	310	13.9	B	2540	620	12.8	B
Off Ramp	4390	1140	16.4	B	3200	660	12.7	B

Table 3-7 Future (2040) Intersection Levels of Service

Location			Weekday A.M. Peak			Weekday P.M. Peak		
			V/C	Delay	LOS	V/C	Delay	LOS
Interchange 1								
Danbury Road/ Mill Plain Road (US 6/202) at Saw Mill Road			--	**42.9**	**D**	--	**23.6**	**C**
Danbury Road (Route 6/202)	EB	TR	0.52	29.8	C	0.73	29.5	C
Mill Plain Road (Route 6/202)	WB	L	0.32	64.1	E	0.47	34.8	C
		T	0.86	59.1	E	0.25	10.0	B
Saw Mill Road	NB	LR	0.58	37.1	D	0.30	15.4	B
Saw Mill Road at I-84 WB Off-Ramp			--	**48.5**	**D**	--	**8.6**	**A**
I-84 WB Off-Ramp	WB	L	0.36	43.0	D	0.49	41.9	D
		LTR	0.95	79.6	E	0.54	13.0	B
Saw Mill Road	NB	L	0.21	13.5	B	0.30	5.4	A
		T	0.20	12.1	B	0.13	3.2	A
Saw Mill Road	SB	TR	0.23	9.0	A	0.24	2.5	A
Saw Mill Road at I-84 EB Off-Ramp			--	**8.5**	**A**	--	**15.1**	**B**
I-84 EB Off-Ramp	EB	LTR	0.55	10.6	B	0.77	21.4	C
Saw Mill Road	NB	T	0.49	13.8	B	0.42	18.8	B
		R	0.22	3.0	A	0.17	4.9	A
Saw Mill Road	SB	LT	0.23	4.3	A	0.35	8.8	A

Table 3-7 Future (2040) Intersection Levels of Service

Location			Weekday A.M. Peak			Weekday P.M. Peak		
			V/C	Delay	LOS	V/C	Delay	LOS
Interchange 2								
Mill Plain Road (US 6/202) at Milestone Road			--	**13.5**	**B**	--	**30.6**	**C**
Mill Plain Road (Route 6/202)	EB	L	0.09	19.5	B	0.41	35.4	D
		TR	0.14	15.3	B	0.70	35.3	D
Mill Plain Road (Route 6/202)	WB	L	0.34	8.0	A	0.74	22.0	C
		T	0.25	7.1	A	0.23	9.4	A
		R	0.07	0.2	A	0.36	7.5	A
Milestone Road	NB	L	0.14	46.5	D	0.16	36.8	D
		T	0.33	48.0	D	0.53	43.4	D
		R	0.74	12.1	B	0.99	46.1	D
Milestone Road	SB	L	0.20	24.3	C	0.42	25.1	C
		TR	0.15	15.8	B	0.30	13.8	B
Milestone Road at I-84 WB Off-Ramp			--	**7.5**	**A**	--	**9.4**	**A**
I-84 WB Off-Ramp	WB	L	0.62	40.7	D	0.37	29.3	C
		TR	0.50	3.2	A	0.80	27.2	C
Milestone Road	NB	LT	0.25	3.8	A	0.52	6.3	A
Milestone Road	SB	TR	0.15	1.0	A	0.34	2.0	A
Milestone Road at I-84 EB Off-Ramp			--	**19.4**	**B**	--	**24.3**	**C**
I-84 EB Off-Ramp	EB	LTR	0.76	35.9	D	0.88	35.6	D
Milestone Road	NB	TR	0.12	6.0	A	0.26	12.7	B
Milestone Road	SB	LT	0.16	9.7	A	0.34	16.9	B

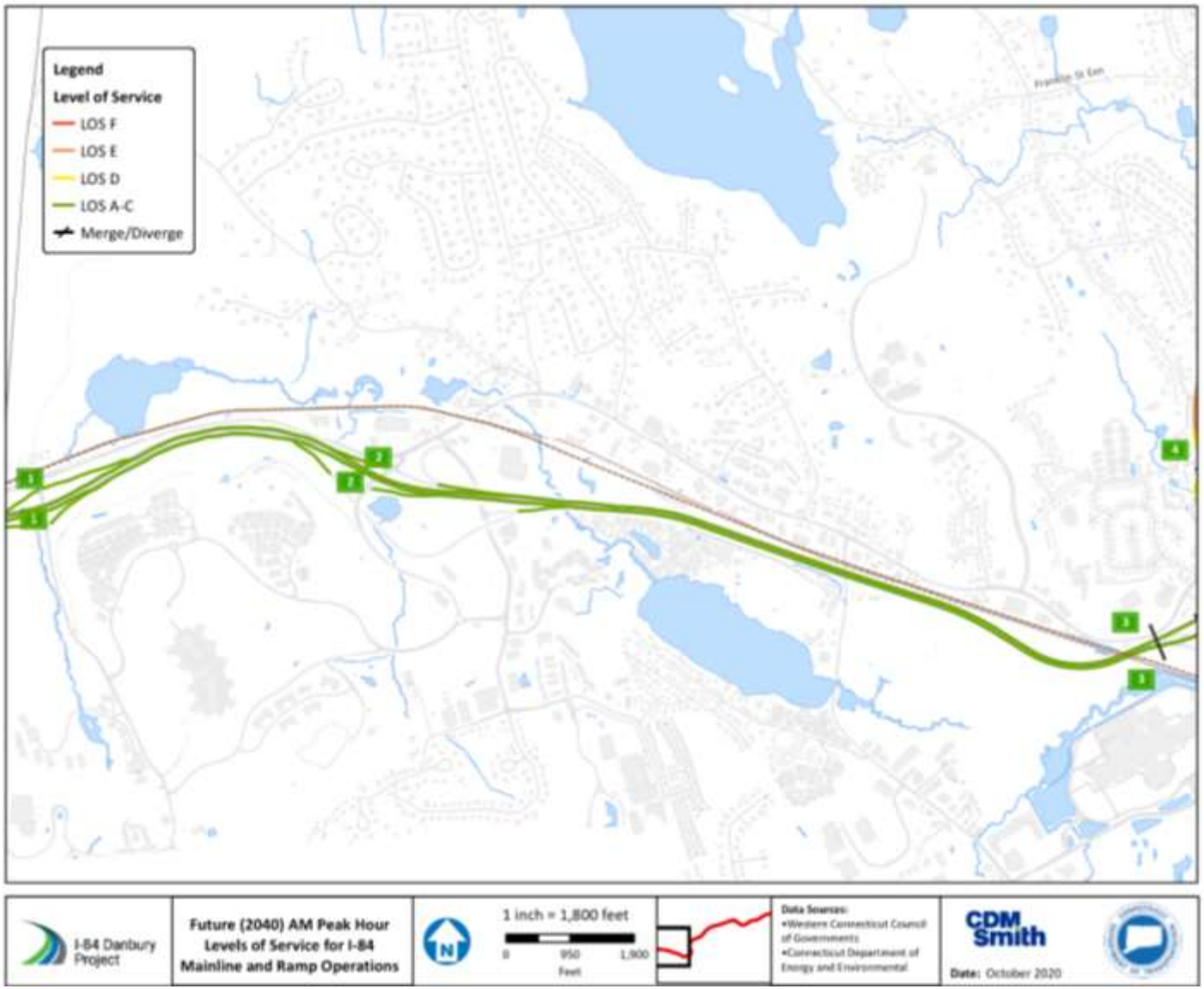

Figure 3-1
Future (2040) Weekday A.M. Peak Hour Levels of Service for I-84

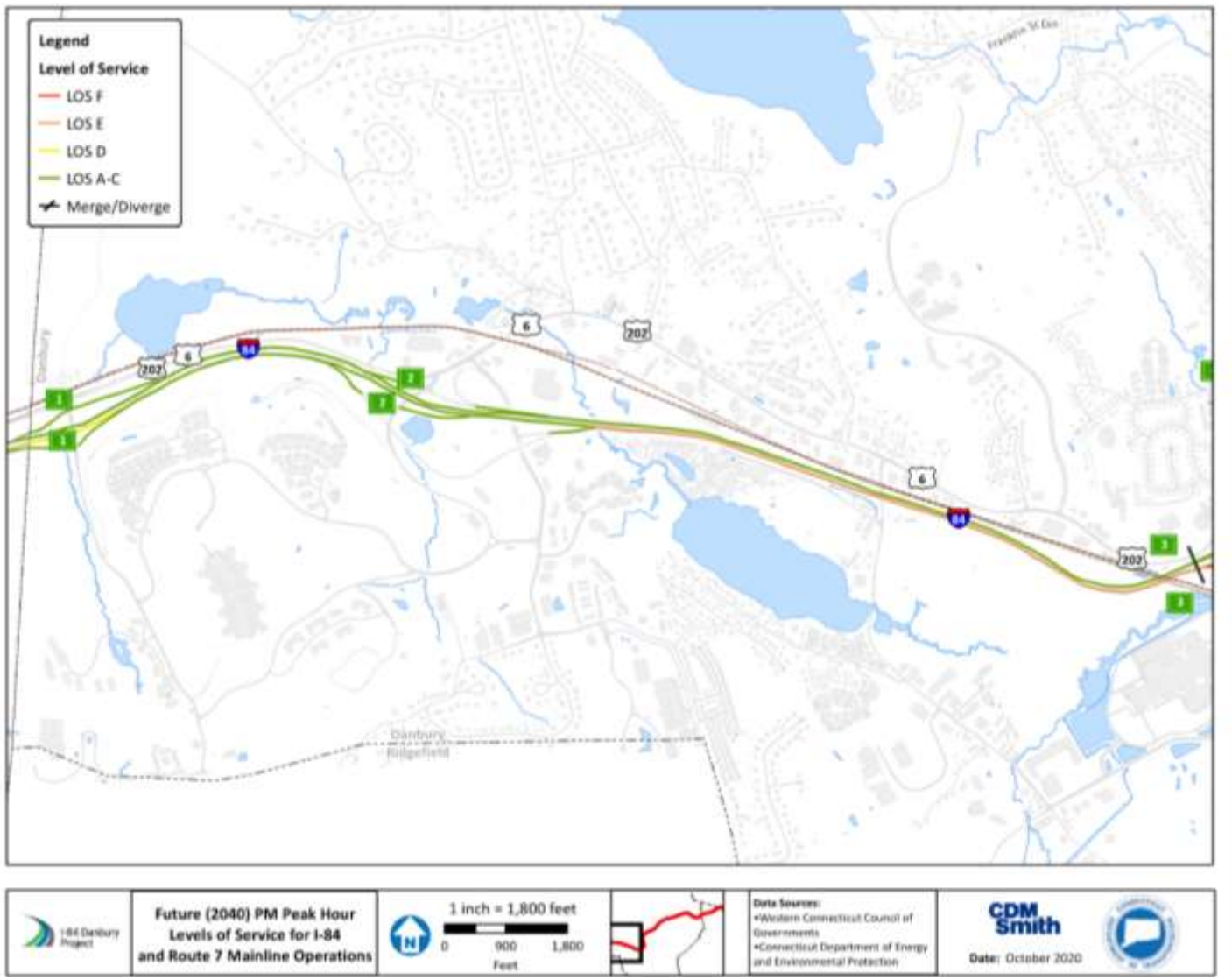

Figure 3-2
Future (2040) Weekday P.M. Peak Hour Levels of Service for I-84

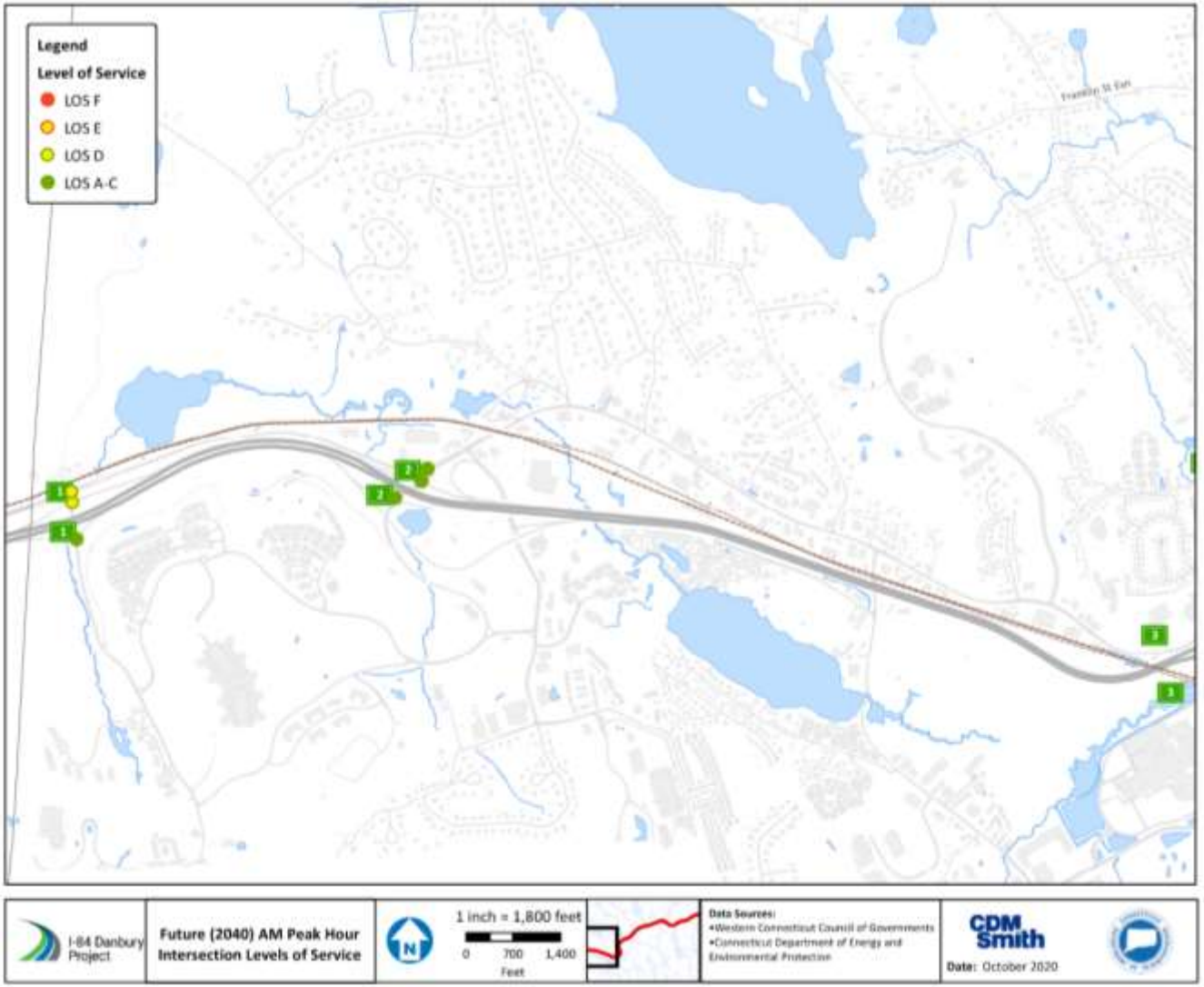

Figure 3-3
Future (2040) Weekday A.M. Peak Hour Intersection Levels of Service

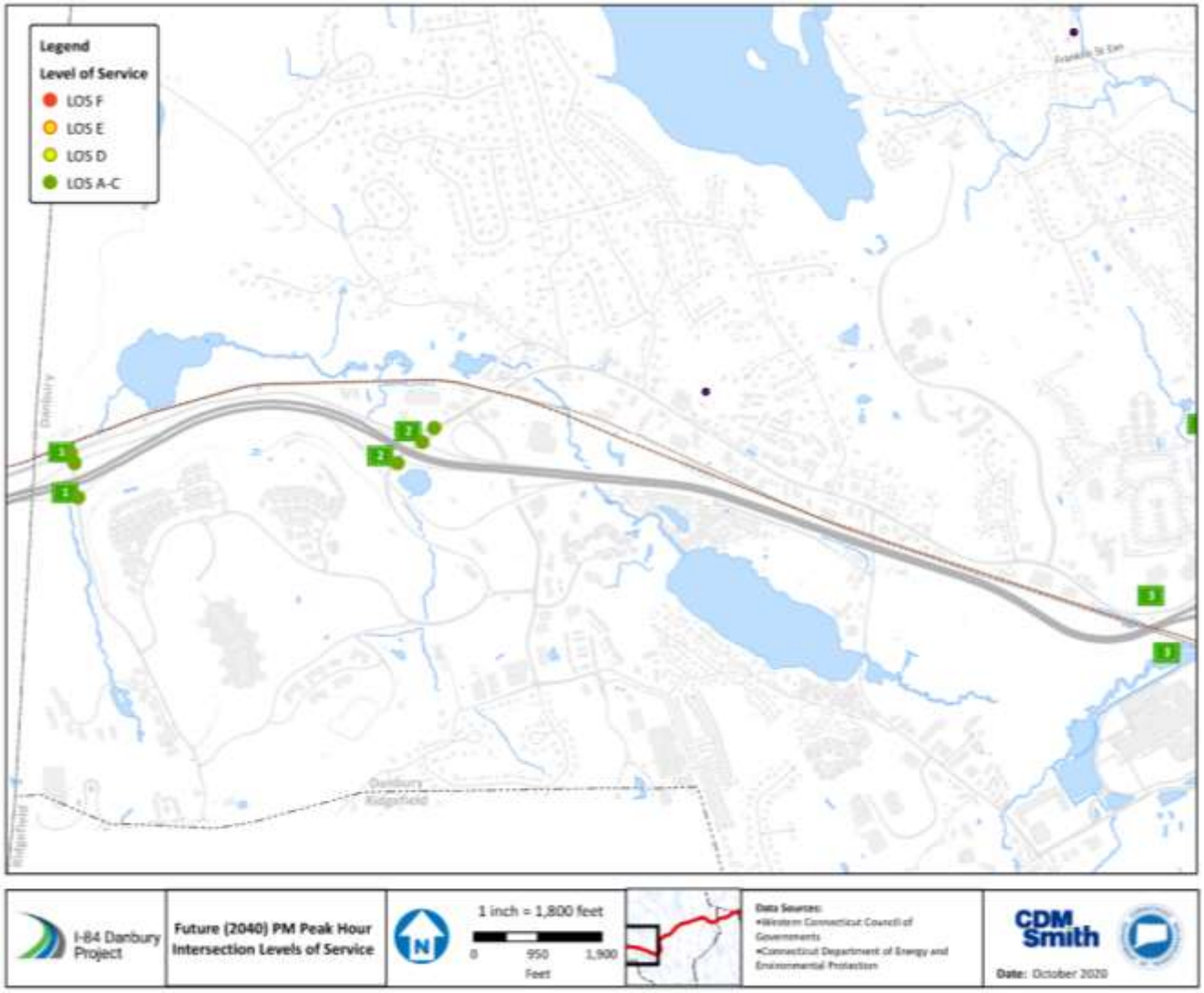

Figure 3-4
Future (2040) Weekday P.M. Peak Hour Intersection Levels of Service

- **Saw Mill Road at I-84 Westbound Off-Ramp** – This intersection is anticipated to operate at an overall LOS D and A during the weekday A.M. and P.M. peak hour periods respectively. During the A.M. peak hour period, the I-84 Westbound off-ramp is anticipated to operate at LOS E. All v/c ratios are less than 1.0.
- The remaining intersections did not consist of any movements with a high v/c ratio and a LOS E or F.

3.4 Future Structure Conditions

This section provides the estimated future component condition ratings for the six structures within the extended project limits, and any likely maintenance, rehabilitation, or replacement required by 2037. The general framework for the criteria and procedure used to determine the future ratings is consistent with what was performed for the October 2018 report. Each bridge's deck, superstructure, and substructure ratings are projected based on historical rating data and other important factors that can affect the rate at which the component deteriorates. The culvert rating is also predicted in the same manner. The bridges within the extended project limits utilize the previously determined base curves for their structure groups (I-84, Over I-84 and Culverts) to project the future condition ratings. The following is a summary of the future condition ratings for the bridges within the extended project limits.

3.4.1 Evaluation Results

Table 3-8 below provides a summary of the future predicted condition ratings and likely required action for the four bridges in the I-84 group.

Table 3-8: **I-84 Predicted Condition Ratings and Likely Required Action**

Bridge No.	2037 Predicted Condition Ratings			Likely Required Action by 2037								Comments
	Deck	Superstructure	Substructure	Minor/Major Maintenance Only	Maintenance and Minor Rehabilitation	Deck Replacement	Deck and Beam Replacement	Major Superstructure Rehabilitation	Major Substructure Rehabilitation	Full Bridge Replacement	Bearing Replacement	
05306	5.2	5.5	5.5	X							X	Routine maintenance, repairs, patching of cracks and spalls, and spot painting of steel likely required. Underside of deck has hairline cracks, efflorescence, and honeycombing. Bearings have up to 1/4" pack rust at Abutment 1 and heavy rust at Abutment 2. There is up to 15%

Bridge No.	2037 Predicted Condition Ratings			Likely Required Action by 2037								Comments
	Deck	Superstructure	Substructure	Minor/Major Maintenance Only	Maintenance and Minor Rehabilitation	Deck Replacement	Deck and Beam Replacement	Major Superstructure Rehabilitation	Major Substructure Rehabilitation	Full Bridge Replacement	Bearing Replacement	
												bearing loss at Abutment 2. There is no movement at many of the bearings, replacement likely required.
05307	5.3	5.8	5.3	X							X	Routine maintenance, repairs, patching of cracks and spalls, and spot painting of steel likely required. Underside of deck has transverse cracks with efflorescence and isolated areas of honeycombing with exposed rebar. Bearings have up to 1/16" pack rust at Abutment 1 and up to 1/8" pack rust at Abutment 2. Bearings at Abutment 2 are misaligned and have cracks in the keeper blocks. Bearing replacement likely required.
05309	5.4	5.8	5.5	X								Routine maintenance, repairs, patching of cracks and spalls, and spot painting of steel likely required. Underside of deck has transverse, longitudinal, and map hairline cracks with efflorescence. Moderate rust on bearing masonry plates and laminated rust at select girders at Abutment 1.
05760	5.5	5.3	4.6						X		X	Routine maintenance, repairs, patching of cracks and spalls, and spot painting of steel likely required. Several girders have isolated areas of minor section loss. Bituminous overlay has longitudinal and transverse cracks and map cracking in lanes. Underside of the deck has transverse cracks with efflorescence and some rust. Longitudinal median 1" wide open joint has dampness and efflorescence on deck below. Light rust throughout bearings, heavy rust on masonry plates up to 1/2" at Abutment 1. Bearing replacement likely along with major substructure repairs.

Table 3-9 below provides a summary of the future predicted condition ratings and likely required action for the one bridge in the Over I-84 group.

Table 3-9: Over I-84 Predicted Condition Ratings and Likely Required Action

Bridge No.	2037 Predicted Condition Ratings			Likely Required Action by 2037								Comments
	Deck	Superstructure	Substructure	Minor/Major Maintenance Only	Maintenance and Minor Rehabilitation	Deck Replacement	Deck and Beam Replacement	Major Superstructure Rehabilitation	Major Substructure Rehabilitation	Full Bridge Replacement	Bearing Replacement	
05308	6.0	5.6	5.8		X							Recent bituminous concrete overlay in good condition, underside of deck has minor map cracking. Lower West fence has collision damage on five panels, as well as cracked welds on fence posts. Light rust on the steel sliding plate expansion bearings at Abutment 1. Routine maintenance; repair and patch cracks and spalls on abutments likely as well as repairing heavy scaling on slope protection. Spot painting of the steel likely required.

Table 3-10 below provides a summary of the future predicted condition ratings and likely required action for the one culvert within the extended project limits.

Table 3-10: Culvert Predicted Condition Ratings and Likely Required Action

Bridge No.	2037 Predicted Condition Ratings	Likely Required Action by 2037			Comments
	Culvert	Minor/Major Maintenance Only	Maintenance and Minor	Major Rehab or Replace Culvert	
02531	5.6		X		Minor spalls and efflorescence present

Figure 3-5 provides a graphical representation of the extended project limits based on the future overall structure condition, which is taken as the minimum rating of deck, superstructure, substructure, and culvert future rating.

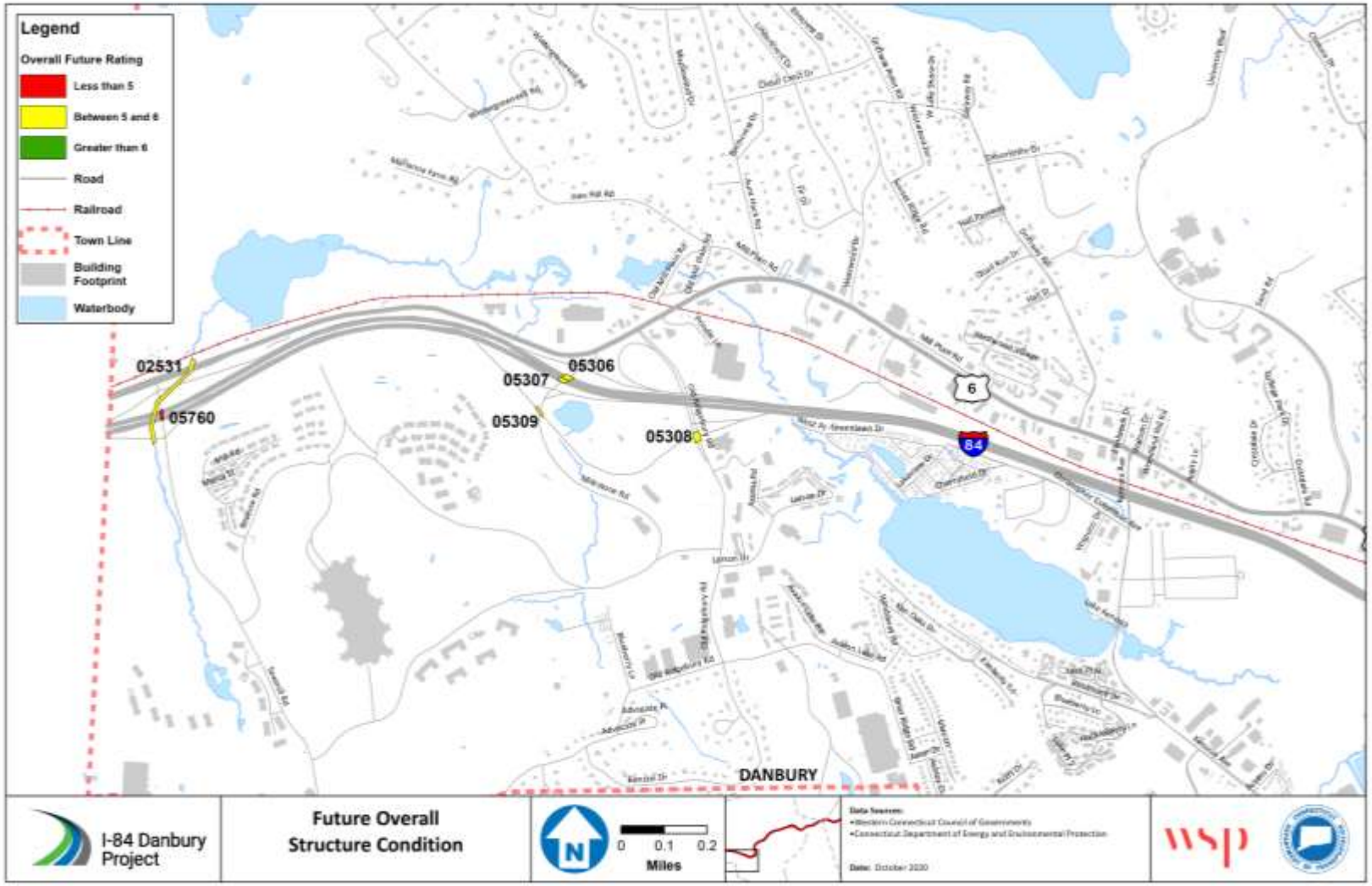

Figure 3-5
Future Overall Structural Condition

Section 4

Summary of Findings and Deficiencies

The following is a summary of the needs and deficiencies identified on I-84 from the vicinity of the New York State Line easterly to the Kenosia Avenue bridge over I-84:

- Substandard shoulder widths between Interchanges 1 and 2 in the eastbound direction.
- Substandard ramp design speed at the Saw Mill Road on-ramp at Interchange 1 in the eastbound direction and at the Old Ridgebury Road/Milestone Road off-ramp at Interchange 2.
- Insufficient intersection capacity at Danbury Road/Mill Plain Road/Saw Mill Road and Saw Mill Road/I-84 Westbound ramp intersections.
- Mainline crashes attributed to peak period congestion. Rear-end crashes are the predominant type.
- High crash rate at the Interchange 1 on/off-ramp termini at Saw Mill Road in the westbound direction.
- Five (5) structures and one (1) culvert on I-84 require maintenance and rehabilitation.
- Deficiencies in existing transit service.
- Lack of pedestrian and bicycle travel.